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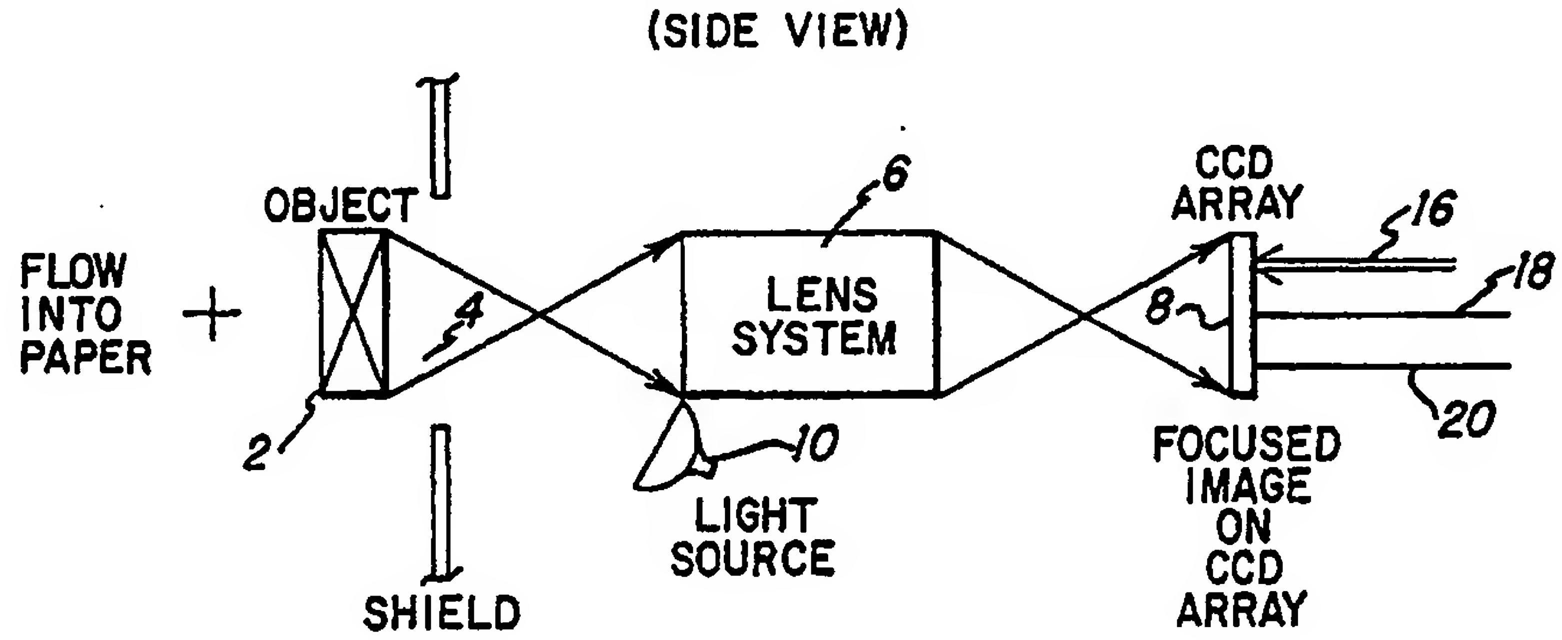
(54) **Image analysis counting system.**

(57) A system for counting overlapped newspapers carried on a moving conveyor which employs an optical sensor which is passive in nature. Accurate count is obtained by image analysis of the image presented by the edge of the newspaper flow as the image is focused on a linear CCD array. Definitive values are determined which are quantitative of the top profile, height, of the newspapers. The processing technique employed determines the rate of change of the height of the image and utilizes the rate of change data to output a newspaper count increment when the rate of change, derivative, of top profile height changes from a positive value to a negative value and the measured profile height exceeds a calibrated value thickness, and outputs two newspaper count increments when the measured profile height exceeds a second calibrated value thickness.

FIG. 1
(SIDE VIEW)



EP 0 383 415 A3

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EUROPEAN SEARCH REPORT

Application Number

EP 90 25 0031

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	GB-A-1 287 115 (VEB KOMBINAT ROBOTRON) * Page 2, line 76 - page 3, line 5; claims; figures 1,2,7 *	1-4,7	G 06 M 7/10 G 06 M 7/00
A	EP-A-0 129 940 (STAALKAT B.V.) * Page 6, line 19 - page 7, line 10; figure 1 *	1,4,7	
A	US-A-4 771 443 (MOHAN et al.)		

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

G 06 M

The present search report has been drawn up for all claims

Place of search	Date of completion of search	Examiner
The Hague	22 August 91	GELEBART Y.C.M.

CATEGORY OF CITED DOCUMENTS

X: particularly relevant if taken alone
Y: particularly relevant if combined with another document of the same catagory
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention

E: earlier patent document, but published on, or after the filing date
D: document cited in the application
L: document cited for other reasons

&: member of the same patent family, corresponding document

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(56) References cited :
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De ription

T chnical Field

This invention relates in general to counting methods and counting systems, and more particularly to an object counting system which utilizes image analysis techniques much in the manner that the human vision system would analyze and count objects.

Background of the Invention

Various systems of counting have been developed in the prior art for the purpose of, for example, counting the number of newspapers conveyed from a newspaper press. These systems fall generally into mechanical, ultrasonic, laser, and infrared categories.

For years, mechanical counters have been used to count newspapers in overlapped stream conveyors and to control the cycling of newspaper stackers. In a few isolated cases, the counts obtained have been fed to totalizing devices of several varieties. The principal advantage of mechanical counters is their relatively low cost. Disadvantages of such counters include inaccurate counting (especially of small size products and of very large awkward products, such as an inserted package), high maintenance and rapid wear-out. Mechanical counters are poorly suited to use with gripper type conveyors now prevalent in newer installations. Also, mechanical counters will not sense doubles.

Ultrasonic counters pick up perturbations in pressure as papers pass under an electro-mechanical transducer. These devices contain many mechanical components that are subject to fouling by paper dust that pervades the operating environment. Ultrasonic counters are somewhat sensitive to variations in paper-to-transducer distance. Unfortunately, such variations are common in newspaper streams. Like their mechanical counterparts, ultrasonic devices will not sense doubles.

Despite the favorable reputation of many laser devices, their use for newspaper counting gets mixed reviews from users -- probably because of their limited shelf life and operating life. The user is not comfortable with the knowledge that a new spare may not work when he needs it. Although the He-Ne lasers commonly used in newspaper counting applications are relatively cheap compared to more powerful laser devices, they do, nonetheless, represent a continuing replacement cost of consequence to the publisher. Laser counters rely on changes in reflected light beams to record counts (c.f. US-A-Re.27 869, US-A-3,840,857 ; US-A-4,227,071 ; US-A-4,384,195 and US-A-4,707,598).

Infrared counters, like laser devices, utilize reflected nergy for counting. They are expensive and d not sens thin products as w ll as thick nes.

In the newspaper publishing business, th need for an accurate count of newspapers being output in a particular press run is essential to the attainment of necessary g od business practices. With th ev r-increasing and skyrocketing cost of newsprint, it is no longer an acceptable business practice in the publishing field to print more newspapers during a particular press run than the calculated demand. Conversely, it is obviously impractical and poor business practice, and, in fact an unacceptable business practice for a pressroom to print considerably more papers than can be sold. In short, it has become imperative that an extremely accurate print count be obtained on the actual output 5 count of a press run, neither too many nor too few.

All of the prior art sensing means cited above rely upon some sort of perturbation. In the case of mechanical counters, the change is to the unperturbed state of the contact star wheel or other mechanism. In 10 the case of all of the other devices, sensing is accomplished by detecting a change in the emitted energy -- such change being the consequence of passage of a newspaper.

EP-A-0 129 940 discloses a counting apparatus for counting objects by means of a shadow measurement. The apparatus is constructed so that it can determine on the basis of measurements of the height and the width of a shadow area whether the shadow area corresponds to one or two objects which pass on a conveyor belt through a light beam.

Summary of the Invention

This invention relates to system as claimed in claims 1 and 3 and to a method as claimed in claim 5.

Brief Description of Drawinas

For a more complete understanding of the present invention and for further advantages thereof, reference will now be made to the following Description of the Preferred Embodiments taken in connection with the accompanying Drawings in which:

Figure 1 is a side view of a functional representation of the optical subsystem as employed in the present invention;

Figure 2 is a top view illustrating the function of the optical shield contained within the optical subsystem as shown in Figure 1;

Figure 3 is a functional block diagram of the signal processing section of the electronics subsystem as employed in the present invention;

Figure 4 is functional block diagram of th microprocessor subsyst m of the present inventi n;

Figure 5 is a diagrammatic representation of th software generated imag of a newspaper as it

passes the s nsor syst m which aids in th explanation of the op rating principl s mployed by the software in the invention; and

Figures 6a-6o are computer flow diagrams illustrating the operation of the present system.

Description of the Preferred Embodiments

The invention to be described provides a method of obtaining an accurate count by image analysis of overlapped newspapers carried on a conveyor. The system is not subject to conveyor speed and/or minimum overlap requirements which exist in mechanical counting systems and all other systems which sense the top of the papers rather than the side edge of the paper run as provided hereby. The system to be described provides a method of obtaining a count of overlapped newspapers carried on moving conveyor by a sensor system which performs image analysis on the image looking at the side edge of the newspaper stream. Utilizing the side edge image of the newspaper stream provides the sensor system with the maximum amount of information so that, for example, newspapers which are directly overlapped or set back underneath another newspaper can be counted and so that, for example, an insert slipped back inside its cover will not be counted twice.

The sensor subsystem to be described includes a lens system, a self-contained illumination source, and a viewing window. The illumination source angle of the light path with respect to the line of vision when passing through the viewing window slot forms an angle such that the regions beyond the focal depth of field are shadowed thereby eliminating a potential source of noise.

The electrical subsystem performs a method of obtaining a count of newspapers carried on a moving conveyor by image analysis of light reflected from the edges of the newspapers as the reflected light impinges on a linear CCD array which is oriented transversely with respect to the newspaper edge image.

The electrical subsystem of the sensor system performs repetitive sequential steps of serially shifting analog outputs from the CCD array to a differential amplifier to remove the D.C. output offset therefrom, amplifies the resulting signals and converts the analog output signal from the differential amplifier to a serial digital output signal as defined by a selected light level.

This serial digital output is applied to a serial in/parallel output shift register from which parallel output is stored in a RAM. The data stored in the RAM is transferred to a microprocessor.

In general the computation subsystem through software control reads th image analysis data in the RAM to creat a representati n in software of the newspap r dg image as it trav ls by th sensor system. The software determines a definitiv numerical representation of the top profil of the newspap r run imag as it passes the ptical system and thereby obtains definitive newspaper height data and change in newspaper height data which is specified as a definitive time derivative of the newspap r height data.

The software utilizes definitive height data and time derivative data to determine calibrated image height and derivative values which are utilized to perform software newspaper count determination.

The software utilizes the instant definitive positive derivative greater than the calibrated derivative as a determination of the leading edge of a newspaper presence, such that the system is self-calibrating. History information pertinent to the previous newspaper profile is saved by microprocessor as a reference for determination of the height of the next overlapping newspaper as it passes by the optical system, and then utilizes the definitive change in the instant or present derivative on the present newspaper profile from positive to negative as an indicator to obtain the present definitive height value with the calibrated height value for determination that the object is a newspaper and initiates a single count output increment when the above criteria has been satisfied. The microprocessor initiates a double count increment when the present definitive height value is compared with a definitive value representing that two newspapers are completely overlapped as they pass by the optical system, and thus utilizes a digitally stored newspaper profile height and rate of change of newspaper profile height to accurately provide an output newspaper count.

The optical subsystem is depicted in Figures 1 and 2. Referring to Figure 1, a flow of overlapped newspapers carried on a conveyor is depicted functionally as the object 2 which is flowing into the plane of Figure 1. in the side view as shown in Figure 1, the object 2 is focused as viewed through a vertical slot 4 by means of a lens system 6 onto a detector array 8 such as, for example, a linear CCD array. As concerns the present invention, the object 2 depicted in Figure 1 represents the side edge of overlapped newspapers as they would be conveyed into (or flow into) the plane of Figure 1. CCD array 8 may comprise, for example, a CCD array model TC103, manufactured and sold by Texas Instruments, Inc., Dallas, Texas.

Figure 2 illustrates a top view of the system depicted in Figure 1 wherein the flow of overlapped newspapers on a conveyor lies in the plane of Figure 2. Light source 10 is depicted in angular relationship with respect to the vertically extending slot 4 in shield 14, such that a shadow is imparted by the shield 14. The line of sight 12 to the slot 4 in shield 14, as it is applied t the lens syst m 6 of Figure 1, is such that light from source 10 is n t visible past a pred termined d pth of field and the shadow imparted by the slot 4 in shield 14 acts to reduce any detrimental

n is influence from the vertical ptical imag "slice" being focused on the lens system 6 in Figure 1. Since the side edge of the paper flow, as newspapers are c nveyed past the vertically extending slot 4 are within the depth of field of the lens system 6, the vertical slice image focused on the CCD array 8 is not influenced by light other than that reflected off the edges of the newspaper flow as it appears in the slot 4. In this manner, the illumination source 10 is seen to be so angled with respect to the line of sight 12 presented to the lens system 6, and subsequently the CCD array 8, forms an angle such that regions beyond the focal depth of field are shadowed, thereby eliminating any potential source of noise.

With reference to Figure 3 analog outputs from the linear CCD array 8 (Figure 1) are input to an image signal processing circuitry 15. Multiple driver lines 16 apply a signal to the detector array 8 to serially shift the analog outputs from the array photodetectors on line 18 and a reference dark level output 20 from CCD array 8 to a differential amplifier 22 to remove the D.C. offset therefrom and amplify the signal and filter high frequency noise therefrom. Output from the differential amplifier 22 is applied on line 24 along with a threshold adjustment signal on line 26 as respective inputs to a comparator 28 whereby the output signal from the differential amplifier 22 is converted to a serial digital output signal as defined by a selected light level on comparator output line 30.

The serial digital output signal on line 30 is input to a serial in/parallel out shift register 32. Parallel output on line 34 from shift register 32 is input to a RAM 36 under control of an addressing line 38 from buffer 62 which receives addressing information on line 64 from timing and logic circuitry 54. The parallel data output from RAM 36 is applied through a buffer 46 on line 48 to microprccessor subsystem 49 (Figure 4).

The image signal processing circuitry of Figure 3 further comprises a clock source 50 which provides an output on a line 52 to timing and logic circuitry 50. Timing and logic circuitry 54 provides an output on line 56 to CCD array drivers 58, the output via lines 16 of which is applied to read the analog information in serial fashion from the linear detector array 8. Timing and logic circuitry 54 additionally applies timing control on line 60 as a control input to buffers 62, 40, and 46 and RAM 36. Timing and logic circuitry 54 provides further control on lines 64 to buffer 62 and on line 66 to the serial-in/parallel-out shift register 32. When a request to read signal is generated by microprocessor 44 (Figure 4) applied to timing and logic circuitry 54 via signal line 55, timing and logic circuitry 54 holds off generating the OK to read signal generated on signal line 57, until the data has completed shifting out of CCD array 8 and into the RAM 36. Then timing and logic circuitry 54 drives lin 60 in rder to enabl buffers 40 and 46 and disabl buffer 62. Timing and logic circuitry 54 also generates a signal via signal lin 66 in ord r to t rminat th shifting of data from shift register 32 into RAM 36. Th address information via line 42 from microprocessor subsystem 49 (Figure 4) is applied via buffer 40 and signal line 38 to RAM 36 so that data previ usly st red within RAM 36 can be applied via line 34 to buffer 46 for output via line 48 to microprocessor 44 (Figure 4).

Thus paralleled output from shift register 32, representing successive parallel-slice images of the edges of the newspapers on the conveyor as developed in the CCD array 8 upon which the image is focused, are applied to microprocessor subsystem 49 (Figure 4) for development of a count of newspapers as they pass by the optical system by using the vertical slice like images of the paper flow edges.

In accordance with the present invention, the microprocessor subsystem 49 (Figure 4) receives digital data from the image signal processing circuitry of Figure 3 via signal lines 48 and from this data the software determines where the top of the image presented to the CCD array 8 of Figure 1 lies. The term top will be defined as the newspaper height. The software determines from the digital data concerning the height of the newspaper run profile from top to bottom where the top of the profile appears in the CCD array 8 of Figure 1. This determination is performed for successive image "slices" as they impinge on the CCD array 8 as the newspapers are conveyed past the detector system of Figure 1.

Referring now to Figure 4, microprocessor subsystem 49 is illustrated and includes microprocessor 44. Microprocessor 44 may comprise, for example, a model TMS7000 manufactured and sold by Texas Instruments Incorporated and which is described in a publication entitled "8-Bit Microcomputer Family", Publication No. SND001B, published by Texas Instruments Incorporated, 1986. Associated with microprocessor 44 is an 8-bit data bus 48 and a 20-bit address bus 42. Higher order addressing decoding is performed by higher address decode circuitry 90 which selects on address line 42 whether microprocessor 44 will be communicating with an erasable programmable read-only memory (EPROM) 92, or a random access memory (RAM) 94, or whether microprocessor 44 will be loading data into a digital-to-analog converter 96. EPROM 92 provides storage for the software utilized with the present invention. RAM 94 is an operational RAM which is used in conjunction with the built-in RAM of microprocessor 44. Digital-to-analog converter 96 provides an analog test output for microprocessor subsystem 49 and operates under the control of EPROM 92 which controls the data to be shifted into digital-to-analog converter 96 depending on the particular test to be perf rmed. On particular test, which will subsequently be d scrib d with respect t Figur 6, is th output of the top profile f a newspaper. A signal which is pr portional t the top dge of the paper is gen rated for test purp ses.

Microprocess r 44 g nerates an utput signal to a one shot device 100. This output signal represents the d tection of a newspaper. The output of one shot device 100 is applied to a line driver 102, and optical isolators 104 and 106. The output of line driver 102 provides an output to a control console which may be located at a remote site. Optical isolator 104 provides an output to a control console requiring isolation from microprocessor subsystem 49. Optical isolator 106 provides an output to a light emitting diode display which is actuated each time a newspaper is detected. In this manner, the operator of the present system can easily determine that the system is operational and detecting newspapers. Microprocessor 44 also generates a signal via a line driver 108 indicating a fault condition which is output to the control console.

An input to microprocessor 44 is also provided via a comparator 110 from a lamp "on" detector which may comprise, for example, a photodetector which is mounted to receive light from light source 10 (Figure 1) and is actuated in the presence of light. The output of the lamp "on" detector is applied to comparator 110 which includes a threshold adjustment. In the absence of a signal from the lamp "on" detector, a signal is generated to microprocessor 44 indicating insufficient light for system operation for use by the software to generate a fault condition. Microprocessor 44 also receives inputs via signal lines 112 comprising a test output select input in order to select a particular test output from digital-to-analog converter 96. Microprocessor 44 also receives inputs from a power on reset 114 and a crystal oscillator 116 for controlling power and timing functions, respectively within microprocessor 44.

The software to be subsequently described with respect to Figure 6, is programmed to obtain the difference between successive determinations of the newspaper run top image (newspaper height). These determinations are made at a clock defined rate and thus correspond to the rate of change (derivative) of the top profile of the paper run as carried by the conveyor past the CCD array. When this derivation of newspaper height changes from a positive (increasing) value to a negative (decreasing) value, the software calculates the maximum height of the newspaper run profile based on a previously determined value of the top profile and at this instant initiates a newspaper count. This procedure is graphically illustrated in Figure 5 wherein the linear CCD array 8 is graphically illustrated in terms of its orientation with an overlapped newspaper run carried on a moving surface of conveyor surface as it might be oriented with respect to a reference plane 70 determined by the bottom of the linear detector array 8. Linear CCD array 8 might comprise, for example, 2048 CCD cells arrang d transverse f the conv yor surface and thus transvers ly of th edges f the overlapped newspapers carried on the c nveyor surfac 68.

A first n wspaper 72 in the overlapped run, as it is conveyed past the linear CCD array 8 causes a large positive d rivative r ferenced from the bottom of the array since n detect rs are illuminated when there is n newspaper present, to the det ctors which are illuminated when the first newspaper "appears". Then an output count pulse is initiated.

Further; referring to Figure 5, the derivative of the newspaper run top profile is obtained from the difference between comparison of successive newspaper height determinations and, as graphically illustrated in Figure 5, is positive from point A to point B. At point B, the rate of change of the top profile (newspaper height) is zero and the derivative of the top profile (height) changes from positive to negative. This negative derivative of the newspaper height continues until the point A_1 in Figure 5 at which time the leading edge of the second newspaper in the run passes the linear detector array 8 and the derivative of the newspaper height goes from negative to positive. Thereafter when the rate change (derivative) of newspaper height goes from positive to negative as at point B_1, a second count is output and the height of the newspaper run is determined by the difference between the top of the profile height measurement at point B_1 and at the top of the previous newspaper immediately prior the derivative changing from negative to positive at point A_1. A calibrated height and derivative value is calculated after the first 16 newspapers pass the sensor 8 and these values are updated on every newspaper thereafter. Initially minimum values are assumed so that no newspapers are missed. When the measured profile height is greater than 3/8 of the reference or calibrated height an output count signal is initiated. If the measured paper run profile height is greater than twice the reference or calibrated height value, two output count signals are initiated. This latter situation is depicted graphically in Figure 5 at point A_2 as two completely overlapped newspapers 76 and 78 pass by the linear detector array 8, the calibrated top profile height being the difference between top profile height determinations at points A_2 and B_2.

Since the system described operates on determinations of the height and the rate of change of the height and the rate of change of height of the top profile of the newspaper run as it is imaged on linear detector array 8 and subsequently processed, environmental conditions, cocked newspapers, rippled edges, etc. the signal which the microprocessor 44 receives may have noise or fluctuation. These perturbations are interpreted by the software as noise and are eliminated. The shielding arrangement, discussed with reference to Figure 2 and the optical arrangement discussed with reference to Figure 1 p-erate in concert to assure immunity against ambient light p rturbations. The depth f fi ld f the l ns system 6 renders the system immun to light perturbations from sourc s beyond that d pth of field while

th shadow provid d by the light shi lding arrangement, through which reflected light is project d through th lens system 6 of Figure 1, furth r provide immunity from ambient light perturbations.

Referring now to Figure 6, comprising Figures 6a-6o of computer flow diagrams, the software for use with the present system will now be described. Briefly, Figures 6a, 6b and 6c represent the main program with branches to the various subroutines of the present system. Figure 6d is a subroutine that initializes all registers within microprccessor 44 and random access memory 94. Figure 6e represents the subroutine for reading random access memory 36 (Figure 3) in order to extract the top profile of a newspaper and assign a relative value for the top edge of the newspaper. Figure 6f is a subroutine for outputting the analog test signal from digital-to-analog converter 96 which is selectable via the inputs from signal lines 112 (Figure 4) to microprocessor 44. Figure 6g represents the program for calculating the positive derivative value when there is an increase and a negative derivative value when there is a decrease in the profile of a newspaper. Figure 6h represents the software of the history subroutine for maintaining a history file of the previous four values for the top of a newspaper and the derivative values. Figures 6i and 6j represent the software for the new detect subroutine and contain the criteria for detecting one or two newspapers and for eliminating erroneous noise perturbations. Figure 6k represents the software for the calibration subroutine and determines the calibration value for height and derivatives. Figure 6l is a flow diagram representing the delay subroutine for spacing the output pulses from microprocessor 44 (Figure 4). Figure 6m illustrates a subroutine for outputting the pulse to trigger one shot device 100 (Figure 4). Figure 6n illustrates the software for a subroutine for detecting a lamp failure by light source 10 (Figure 1) and when a newspaper has gone above the top of detector array 8 in order to output a fault indication output from line driver 108 (Figure 4). Figure 6o illustrates a subroutine for generating a timing interrupt used to space the output pulses and to determine when it is time to recalibrate the system because no newspaper has gone past detector array 8 for a predetermined time period.

Referring now to Figure 6a, the stack pointer is loaded at block 120 in order to partition a predetermined amount of random access memory in microprocessor 44. At block 122, the initialize subroutine loads all the initial values to zero in the initial registers of microprocessor 44 and random access memory 94 (Figure 4). A decision is then made at block 124 to determine whether it is time to recalibrate the system. Detector array 8 automatically recalibrates if there has not been any newspap rs detected within approximately, for exampl , fiv minutes. A register within microprocessor 44 is checked to determine its state. If th register contains a zero, the time to recalibrat has not pass d, and if th register contains a on , then recalibration is performed.

If no recalibration is necessary, the top fetch subroutine is called at block 126. The top fetch subroutine fetches the top of the newspaper array, and will be discussed with respect to Figure 6e. A decision is then made at block 128 to determine if the top of the newspaper is above detector array 8. If the decision is yes, a counter is incremented at block 130 and if the counter is equal to FF (HEX) at decision block 132, a problem bit is set at block 134 which outputs a fault signal, and the fault subroutine is called at block 135. If the decision at block 132 is no, the program calls the fault subroutine at block 135.

The fault subroutine is called at block 135 which will be described with respect to Figure 6n which checks all the problem bits to determine if any one bit is set. A decision is then made at block 136 to determine if a newspaper is present at detector array 8. A newspaper is present at detector array 8 if any one of the 2048 detectors is illuminated. If the answer at block 136 is no, the derivative subroutine (Figure 6g) is called at block 138; the history subroutine (Figure 6h) is called at block 140; and the digital-to-analog converter (DAC) subroutine (Figure 6f) is called at block 142 and the program loops back to decision block 124.

If the decision at block 136 is that a newspaper is present, a decision is made at block 144 to determine if there was a previous newspaper present. If no previous paper was present, the program continues to Figure 6b, and if a previous paper was present, the program continues to Figure 6c.

Referring now to Figure 6b, the derivative subroutine is called at block 150. This subroutine is calculating from point to point or from sample to sample the difference in the derivative value in the profile of a newspaper passing detector array 8. The history subroutine is called at block 152. This subroutine saves in a rotating file four data points of the profile of a newspaper as well as the top of the newspaper and the derivatives. The program continues by calling the digital-to-analog converter (DAC) subroutine at block 154 which outputs to digital-to-analog converter 96 (Figure 4) information such as, for example, the top of the newspaper. The next subroutine called is the new detect (NEW DET) subroutine at block 156 which detects when there is actually a newspaper present at detector array 8, when an output pulse should be generated representing a newspaper being present and whether one or multiple newspapers are present.

A decision is then made at block 158 to determine if the output pulse register is set. The output pulse register within microprocessor 44 may contain four s ttings indicating that: 1) an output pulse should not b g nerated; 2) a first criteria for utputting a puls , a large positiv derivative has been satisfied; 3) th s cond criteria that a zero derivative has been passed

and the siz indicates ne n wspap r present; r 4) that two n wspapers are present. Th se conditions are repres nted by a zero, one, tw r three contained within th utput pulse register. If the output pulse register contains a zero, the program returns to block 124 (Figure 6a).

If output pulse register is set to output a pulse then the decision at block 158 is yes and the counter registers of microprocessor 44 are then cleared at block 160. The counter registers within microprocessor 44 count continuously for a predetermined time intervals such as, for example, five minutes, to determine when it is required to recalibrate the system by determining the thickness of a newspaper for detecting the presence of subsequent newspapers. The calibration subroutine (Figure 6k) stores the values of the first sixteen newspapers which have passed detector array 8. After the first sixteen newspapers have passed, the system is calibrated to determine whether a single newspaper or double newspaper has passed detector array 8. If there is a gap in the stream of newspapers of, for example, five minutes, when no newspapers are present, recalibration is required because, for example, different sized newspapers may be subsequently processed. Therefore, the counter registers are cleared.

After the output pulse register is set, a bit is then set at block 162 to indicate the presence of a previous newspaper for the next newspaper. A decision is then made at block 164 to determine if the inhibit output pulse bit is set. If the inhibit output pulse bit was set, no pulse is output and the inhibit pulse bit is cleared, and all registers are cleared at block 166, and the main loop starts again at block 124 (Figure 6a).

If the inhibit output pulse bit was not set, the program continues by calling the delay subroutine at block 168. This subroutine actually outputs the pulses from microprocessor 44 and insures that there is a minimum spacing between the pulses output by microprocessor 44. Spacing may be, for example, 10 milliseconds between pulses. The registers that were set before the pulse was output are then cleared at block 170 and the program continues to block 124 (Figure 6a).

Referring now to Figure 6c, if a previous newspaper was present, the derivative subroutine, digital-to-analog converter subroutine, and new detect subroutine are called at blocks 180, 182 and 184, respectively. A decision is made at block 186 to determine if the output pulse register is set, if the decision is no, the program continues to decision block 124 (Figure 6a).

If the decision at decision block 186 is yes, the counter registers are cleared at block 188, and the bit to indicate that there was a previous newspaper is set at block 190. A decision is then made at block 192 t d termine if the inhibit puls was s t. If th inhibit utput pulse was set, no pulse is output and all the registers are clear d at block 194, and the program continues t d cisi n block 124 (Figur 6a). Up t this point in th "B branch" of the main program, the steps are identical to the "A branch" (Figure 6b). How ver, if th inhibit output pulse was not set, the calibrati n subroutine (Figure 6k) is called at block 196, and the program continues by calling the delay subroutine (Figure 6l) at block 198 and the registers are cleared that were set before a pulse was output at block 200, and the program continues to decision block 124 (Figure 6a).

Referring now to Figure 6d, the initialize subroutine is illustrated. The program of Figure 6d initializes microprocessor 44 at block 210, initializes interrupts of microprocessor 44 at block 212, initializes the input/outputs of microprocessor 44 at block 214, clears the registers of microprocessor 44 at block 216, clears random access memory 94 at block 218, sets the initial height criteria for newspapers at block 220, and sets the initial derivative criteria at block 222. Initialize program then returns to main program (Figure 6a).

Referring to Figure 6e, the software program for the top fetch subroutine is illustrated. The CCD array 8 enable bit is read at block 230. A decision is made at block 232 to determine if the enable bit is a one. If the enable bit is not, the program returns to read the enable bit at block 230. If the bit is a one, the enable bit is again read at block 234 and a decision is made at block 236 to determine if the enable bit is a zero. If the enable bit is not a zero, the bit is read again at block 234. if the enable bit is a zero, confirmation has been made that the enable bit has toggled and the bytes of RAM 36 (Figure 3) are read at block 240. If the byte is equal to ØØ HEX at decision block 242, a counter within microprocessor 44 is incremented by eight at block 244. A decision is then made at block 246 to determine if the count is a maximum value. If the count is the maximum value, a register is set within microprocessor 44 indicating that no newspaper is present at block 248. If the maximum count is not present, the bytes of RAM 36 (Figure 3) are read again at block 240. The counter that is incremented at block 244 represents a count corresponding to the top value of a newspaper. If the counter is at the maximum value, the entire array of CCD array 8 has been scanned and no newspaper has been found.

If the decision at block 242 is no, a byte that is not equal to zero has been found, and it must be determined which bit in the byte is the first one, and a rotating write through carry operation is performed at block 250. If the carry is a one at decision block 252, the value of the counter does equal the top of the newspaper and a signal is generated at block 254. If the decision at block 252 is no, the counter is incremented by one at block 256 and th program returns to block 250. Once th t p f the newspaper has be n det rmined and the count r has been s t, th program returns to the main program (Figur 6a).

R ferring n w to Figure 6f, th digital-to-analog converter subroutin is illustrated. This subroutine provides the analog test signal from microprocessor subsystem 49. A decision is mad at block 270 to determine if the I/O bit 6 is set. If I/O bit 6 is set, a decision is then made at block 272 to determine if I/O bit 4 is set. If I/O bit 4 is set, a decision is then made at block 274 to determine if I/O bit 3 is set. If bit 3 is set, the A Register within microprocessor 44 is loaded. The A Register of microprocessor 44 contains the derivative value. The 8 bit value of the A Register is an output at block 278 to the digital-to-analog converter.

If I/O bit 3 was not set, Register A is loaded with ØØ HEX and this value is output to the digital-to-analog converter 96 (Figure 4) at block 278. If bit 6 and bit 4 were set, the signal output to microprocessor 44 is a position input which is input via bit 3. Therefore, it is bit 3 that will be the output as the test signal at block 278.

If bit 6 is set, and bit 4 is not set, the decision at block 272 will be followed by loading Register A with a derivative value at block 280 which will be output as the test signal. If bit 6 is not set, a decision is made at block 282 to determine if bit 5 is set. If bit 5 is set, Register A is loaded with the calibration value at block 284. If bit 5 was not set, register A is loaded with the top value of the newspaper which is output as the test signal at block 278. Therefore, the test signal may include either the value of the top of the newspaper, the calibration value, the derivative value, or the position input depending upon the setting of I/O bits 3, 4, 5 and 6.

Referring now to Figure 6g, the derivative subroutine is illustrated. A decision is made at block 300 to determine if the new top value of the newspaper is greater than the previous top value. If the new top value is greater than the previous top value, the new value is subtracted from the previous value at block 302. If the value after subtraction is greater than or equal to HEX 80, the value is set equal to HEX 80 at block 304. The new top value is then subtracted from HEX 80 at block 306 and this value is then input to the derivative register of microprocessor 44 at block 308 and the program returns to the main program.

If the new top value was less than the previous value, a subtraction is made by subtracting the previous value from the new value at block 310. If the resulting value is greater than HEX 80, the value is set equal to HEX 80 at block 312, and the difference is added to HEX 80 at block 314. This value is then moved to the derivative register at block 308. The purpose of the derivative subroutine of Figure 6g is to ensure that the positive derivative changes are above a center reference and negative derivative changes are below a cent r referenc where HEX 80 represents an offset value.

Referring now to Figure 6h, the history subroutine is illustrated which functions t maintain a history of th previous four valu s for th top of th newspap r and the derivativ values. A determinati n is made at block 320 t determine if th r calibration register is set. If the register is set, th value of ØØ (HEX) is stored in the top newspaper file at block 322. The value of 80 (HEX) is stored in the derivative file at block 324. If the decision at block 320 were no, the program continues to shift the top data to the next storage position at block 326. The previous data stored in the highest memory location is then dropped. The present data is stored in the lowest memory location at block 328. The derivative data is shifted into the next storage position at block 330, and the previous data stored in the highest memory location for the derivative data is dropped. The present derivative data is then stored in the lowest memory location at block 332 and the program returns to the main program (Figure 6a).

Referring now to Figure 6i, the new detect subroutine which contains the software for detecting a single or double newspaper is illustrated. A comparison is made at block 340 to compare the new derivative value with the previous value before a large negative drop to determine if the drop is greater than or equal to 10 (HEX). This comparison performs noise filtering to insure that the edge of a newspaper is actually present, and that folds within a newspaper do not appear as actual newspapers. If the criteria at decision block 340 is met, the inhibit pulse register at block 342 is cleared to begin the process of preventing a count pulse since no newspaper is actually present.

If the decision at block 340 is no, representing that a single newspaper is present, the program continues at block 344 by retrieving the previous derivative. A decision is then made at block 346 to determine if the previous derivative value is greater than the calibrated derivative value. If the decision is yes, register 45 is set equal to one at block 348, and if the decision is no, register 45 is set equal to zero at block 350. A decision is then made at block 352 to determine if the new derivative value is greater than or equal to the calibrated derivative value. If the decision is yes, a register 46 is set equal to one at block 354, and if the decision is no, register 46 is set equal to zero at block 356.

A decision is then made at block 358 to determine if the new derivative value is less than the maximum derivative value. The function of this inquiry is to determine if the negative derivative value drops more than a certain amount and if this decision is yes, the data represents noise, and the inhibit pulse register is set at block 360. The setting of the inhibit pulse register will thereby inhibit the next pulse when this condition occurs. Th previous value before the large negative derivative jump is saved at block 362 and a boundary valu is add d to the previous value at block 364. A d cision is th n made at block 366 to de-

termine if th value st red within r gister 45 is qual to the value stored within register 46. If the answer is yes, indicating that there is a flat slope, the new detect subroutine is re- xecuted. If the decision at block 366 is no, a decision is made to determine if the value of register 45 is greater than the value of register 46 meaning that register 45 contains a zero and register 46 contains a one at block 368. If this decision is yes, the top edge of the newspaper has been located and the profile is decreasing, having passed through the zero derivative point and the new detect program continues with Figure 6j. If the decision at block 368 is no, the value of register 46 is equal to one and the value of register 45 is equal to zero, the first criteria for a newspaper being present is set at block 370, indicating that there is a positive change in the derivative. The lowest value for the thickness calculation is then saved at block 372 and the new detect subroutine is re-executed.

A new detect program is continuously re-executed until the value stored in register 45 is greater than the value stored in register 46 at which point the new detect program continues at Figure 6j and the lowest value of the newspaper top is retrieved at block 380. The newspaper thickness is then calculated at block 382. A decision is then made at block 384 to determine if the calculated thickness is greater than the calibrated value. If this criteria is met, a decision is made at block 386 to determine if register 23 is set equal to 1. If the answer is yes, the criteria for a newspaper being present is satisfied, and register 23 is set equal to 2 at block 388. If either of the decisions at blocks 384 and 386 were no, indicating that the criteria for a newspaper being present are not satisfied, the new detect program is re-executed.

A decision is then made at block 390 to determine if there was a prior newspaper present. If the answer is yes, a decision is made at block 392 to determine if the thickness is greater than or equal to the calculated value for a double newspaper being present. If the thickness criteria is satisfied, register 23 is set equal to a three at block 394. The value of register 23 for the previous fifteen newspapers is then shifted into RAM 94 (Figure 4) and a new value is also shifted into RAM 94 at block 398. The new detect subroutine is then re-executed.

Referring now to Figure 6k, the calibration subroutine determines the calibration value for height and derivative value. Present within microprocessor 44 is a counter which is initialized to zero. The first sixteen newspapers passing CCD array 8 are utilized for generating a calibration value for height. The height values for the first sixteen newspapers are loaded into RAM 94 (Figure 4). A decision is made at decision block 410 to determine if th sixteen newspapers have pass d CCD array 8. If less than sixte n hav pass d, the calibration subroutin c ntinues. A yes decisi n at block 410 indicates that all sixteen newspapers hav passed CCD array 8 and th sixt en values are summed at block 412. Th sum is divided by sixteen at block 414, and the calibration value for newspaper height is set up at block 416. The calibration values are set at block 418 and the calibrat subroutine is completed and the program returns to the main program (Figure 6a).

Referring to Figure 6l, the delay subroutine is illustrated and functions to space the output pulses for the count of newspapers. A decision is made at block 430 to determine if the value stored within a timer register of microprocessor 44 is greater than or equal to 10 milliseconds since the previous interrupt pulse. If the decision is no, the delay of 10 milliseconds is introduced at block 432. If the decision is yes, the output subroutine (Figure 6m) is called at block 434. A decision is then made at block 436 to determine if two pulses are to be output. If the decision is yes, indicating that the value within register 23 is equal to three, indicating two newspapers present, a delay of an additional 10 milliseconds is introduced at block 438 and the output subroutine (Figure 6m) is called at block 440. The program then returns to the main subroutine (Figure 6a).

Referring now to Figure 6m, the output subroutine is illustrated which outputs the pulse to trigger one shot device 100 (Figure 4). The output subroutine functions to change the input/output bit one to a zero at block 442, introduce a delay of, for example, five microseconds at block 444 and change I/O bit one back to a one at block 446. Changing of I/O bit one from a zero to a one triggers one shot device 100 (Figure 4) which is set to output the pulse for a 10 millisecond width. The delay introduced by the output subroutine is not critical, so long as it is less than the output of one-shot device 100.

Referring now to Figure 6n, the fault subroutine is illustrated for detecting a failure of light source 10 or whether the newspaper has gone above linear detector array 8 to output a fault condition. A decision is made at block 450 to determine if I/O bit 7 is set. Bit 7 is the input from lamp "on" detector (Figure 4). If bit 7 is not set, bit 1 in a problem register within microprocessor 44 is cleared at block 452. If the bit 7 is set, bit 1 in the problem register is set at block 454. A decision is then made at block 456 to determine if the problem register is set equal to ØØ HEX from another location within the program. If the decision at block 456 is yes, then the I/O bit 2 is reset at block 458, and if the decision is no, the I/O bit 2 is set at block 460. The program then returns to the main program (Figure 6a).

Referring now to Figure 6o, the interrupt subroutine is illustrated for entering an interrupt every, for example, .33 millis conds so that microprocessor 44 generates an interrupt f r increm nting a c unter at bl ck 480. The counter at block 480 is reset after the output of a pulse. If no n wspapers have gone past

detector array 8, the counter continues t count. A decision is mad at block 482 to determine if the count is greater than 3A98 (HEX) representing the passage of five minutes. If the decision is yes, the recalibrati n bit is set at block 484, since no newspapers have passed by detector array 8.

If the decision at block 42 is no, a decision is made at block 486 to determine if the output pulse bit is set. If the output pulse bit is set, the counter representing the time between output pulses is decremented at block 488. A decision is then made at block 490 to determine if the minimum time is zero. If the time is zero, the next output pulse is enabled at block 492. If the decision is no, the interrupt program returns to the main program (Figure 6a). Microprocessor 44 will automatically generate the interrupt to execute the interrupt program of Figure 6o.

While the present invention has been described with respect to a particular embodiment thereof, it is not to be so limited, as changes might be made therein which fall with scope of the invention as defined in the appended claims.

Claims

1. A system for obtaining a count of overlapped newspapers (2) having side edges, the newspapers (2) carried on a moving conveyor comprising:

first means (16) for optically focusing the side image of the newspapers (2) on a linear detector array (8), said linear detector array (8) being disposed transversely to the side edges of the newspapers (2) and transversely to the conveyor axis of motion;

second means (16) for serially shifting analog outputs at a clock defined rate from said linear detector array (8) to differential amplifier means (22), said differential amplifier means further receiving a reference dark level output (20) from linear detector array (8) for removing the DC offset therefrom;

third means (28) receiving the output (24) from said differential amplifier means (22) and for converting said differential amplifier means output (24) to a serial digital output signal (30) as defined by a selected light level,

a serial-in/parallel-out shift register (32) receiving said third means (28) output signal (30), <u>the system characterized by:</u>

a microprocessing means (44), for developing an image top profile value of the newspaper flow image as it appears in said linear detector array (8) based upon the output of said shift r gister (32) aft r all analog utputs have b n shift d from said linear d tector array (8); m ans (300) for comparing the difference between suc c ssiv n wspap r imag top profil values to obtain a derivative of successive image top profile values;

means (370) for initiating a newspaper count output when the rat of change of successive image top profile values changes from positive to negative; and

means (382) to develop a newspaper thickness definite value, said newspaper count output comprises a single count increment when said newspaper thickness definitive value exceeds a calibrated thickness value and said newspaper count output comprises a double count increment when said measured newspaper thickness exceeds a second calibrated thickness value.

2. The system defined in claim 1 wherein said means (6) for optically focusing the side image of the newspapers (2) on said linear detector array (8) comprises a light source (10), a light shielding member (14) having an elongated through-slot (4) formed therein, said slot (4) being oriented transverse of the surface of the newspaper conveyor, a lens system (6) oriented along the line of sight (12) between said slot (4) and said linear detector array (8), said lens system (6) focusing the slot defined image of the side edges of the newspapers (2) on said linear detector array (8), said light source (10) being angular oriented with respect to the line of sight (12) between said linear detector array (8) and the side edge of the newspapers (2) whereby light beyond a predetermined depth of field defined by said lens system (6) is well below the adjustable threshold detection level and the side edges of the newspapers are focused on said linear detector array (8) are illuminated.

3. A system for obtaining a count of overlapped newspapers (2) having side edges, the newspapers (2) carried on a moving conveyor comprising:

a linear CCD array (8) oriented transversely of the side edges of said newspapers (2) and transversely of the conveyor axis of motion;

means (6) for optically focusing the side image of said newspapers on said linear CCD array (8);

means (32) for continuously serially shifting outputs (30) from said linear CCD array (8) at a clock defined rate, <u>the system characterized by:</u>

signal processing means (44) for receiving said serially shifted outputs (30) from said linear CCD array (8) aft r all utputs hav b en shift d from said linear CCD array (8),

said signal processing means (44) comprising means (254) for devel ping clock defined

repetitiv s qu ntial digital valu s definitiv of the top profil of said n wspapers as said newspapers (2) are conveyed past said linear CCD array (8),

means (300) for comparing ach f said digital values with the next preceding one of said digital values to obtain derivative value of the top profile of said newspapers (2),

means (370) for initiating a newspaper count output increment when said derivative value changes from positive to negative,

means (382) to develop a newspaper thickness definite value from a comparison between the previous newspaper top profile and the existing newspaper top profile value, and difference value calculated from sample to sample changes from positive to negative of the existing newspaper, said newspaper count output comprising a single count increment when said newspaper thickness definitive value exceeds a calibrated value thickness, and said newspaper count output comprising a double count increment when said newspaper thickness value exceeds a second calibrated value thickness.

4. The system defined in claim 3 wherein said means (6) for optically focusing the side image of said newspapers (2) on said linear CCD array (8) comprises a light source (10), a light shielding member (14) having an elongated through-slot (4) formed therein, said slot (4) being oriented transverse of the surface of said newspaper conveyor, a lens system (6) oriented along the line of sight (12) between said slot (4) and said linear CCD array (8), said lens system (6) focusing the slot defined image of the side edges of said newspapers (2) on said linear CCD array (8), said light source (10) being angular oriented with respect to the line of sight (12) between said linear CCD array (8) and the side edge of said newspapers (2) whereby light beyond a predetermined depth of field defined by said lens system (6) is well below the adjustable threshold detection level and the side edges of said newspapers are focused on said linear CCD array (8) are illuminated.

5. A method of obtaining a count of overlapped newspapers (2) carried on a moving conveyor by image analysis of the image of the side edges of said newspaper (2) as the focused image impinges on a linear CCD array (8) oriented transversely of said newspaper (2) side edges and transversely of the conveyor axis of motion, comprising the r petitiv sequential steps of:

serially shifting anal g outputs (16) fr m the linear CCD array (8) and a reference light level output (20) to a differential amplifier (22) to remove th D.C. offs t th refrom, amplify and filter high frequency nois therefrom;

converting (28) the analog output signal from said differential amplifier (22) to a serial digital output signal (30) as d fined by a s lected light level;

applying said serial digital output (30) to a serial-in/parallel-out shift register (32);

storing the parallel output from said shift register (32) in a random access memory (36), <u>the method characterized by</u>:

transferring data in said random access memory (36) to a microprocessor (44) for developing (254) a value definitive of the top profile of the newspaper image as it appears on the linear CCD array (8) after all analog outputs have been shifted from said linear CCD array (8);

obtaining the difference (300) between successive newspaper image top definitive value to obtain a value definitive of the rate of change of said top definitive values;

determining (370) the thickness of the newspapers when the rate of change of said top definitive value changes from positive to negative;

initiating (382) a single count increment when the rate of change of successive top definitive counts goes from positive to negative and the measured thickness of the newspapers exceeds a first calibrated value thickness; and

initiating (382) a double count increment when the rate of change of successive top definitive values changes from positive to negative and the measured thickness of the newspapers exceeds a second calibrated value thickness.

Patentansprüche

1. System zum Erhalten eines Zählwertes von überlappten Zeitungen (2), die Seitenkanten haben, wobei die Zeitungen (2) auf einem sich bewegenden Förderer transportiert werden, welches umfaßt:

ein erstes Mittel (16) für das optische Fokussieren des Seitenbildes der Zeitungen (2) auf ein lineares Detektorfeld (8), wobei dieses lineare Detektorfeld (8) quer zu den Seitenkanten der Zeitungen (2) und quer zur Bewegungsachse des Förderers angeordnet ist;

ein zweites Mittel (16) für das serielle Verschieben analoger Ausgangssignale mit einer definierten Taktgeschwindigkeit von diesem linearen Detektorfeld (8) zu einem Differentialverstärkermittel (22), wobei dieses Differentialverstärkermittel w it rhin ein Bezugs-Dunkelpeg l-Ausgangssignal (20) von dem lin aren Detektorf ld (8) für di Bes itigung d r Gleichstrom-Off-

s tspannung daraus mpfängt;

ein drittes Mittel (28), das den Ausgang (24) aus dem Differentialverstärkermittel (22) empfängt, und für di Umwandlung des Ausgangs (24) aus diesem Differentialverstärkermittel in ein serielles digitales Ausgangssignal (30), wie es durch einen gewählten Lichtpegel definiert ist;

ein Schieberegister mit seriellem Eingang und parallelem Ausgang (32), das das Ausgangssignal (30) aus dem dritten Mittel (28) empfängt, **gekennzeichnet durch:**

ein Mikroprozessormittel (44) für die Entwicklung eines Bildoberseitenprofilwertes des Zeitungsfließbildes, wie es in dem linearen Detektorfeld (8) erscheint, auf Basis des Ausgangs aus dem Schieberegister (32), nachdem alle analogen Ausgangssignale von dem linearen Detektorfeld (8) verschoben sind; ein Mittel (300) für das Vergleichen der Differenz zwischen aufeinanderfolgenden Zeitungs-Bildoberseitenprofilwerten, um eine Ableitung für aufeinanderfolgende Bildoberseitenprofilwerte zu erhalten;

ein Mittel (370) für das Auslösen eines Zeitungszählwert-Ausgangssignals, wenn die Änderungsrate aufeinanderfolgender Bildoberseitenprofilwerte sich vom Positiven zum Negativen ändert;

ein Mittel (382), um einen definitiven Zeitungsdickenwert zu ermitteln, wobei das Zeitungszählwert-Ausgangssignal ein einziges Zählwertinkrement umfaßt, wenn der definitive Zeitungsdickenwert einen geeichten Dickenwert überschreitet und das Zeitungszählwert-Ausgangssignal ein doppeltes Zählwertinkrement umfaßt, wenn die gemessene Zeitungsdicke einen zweiten geeichten Dickenwert überschreitet.

2. System nach Anspruch 1, wobei das Mittel (6) für das optische Fokussieren des Seitenbildes der Zeitungen (2) auf das lineare Detektorfeld (8) eine Lichtquelle (10), ein lichtabschirmendes Element (14), das einen länglichen darin ausgebildeten Durchgangsschlitz (4) hat, wobei dieser Schlitz (4) quer zur Oberfläche des Zeitungsförderers orientiert ist, ein Linsensystem (6), das entlang der Sichtlinie (12) zwischen dem Schlitz (4) und dem linearen Detektorfeld (8) orientiert ist, umfaßt, wobei dieses Linsensystem (6) das durch den Schlitz definierte Bild der Seitenkanten der Zeitungen (2) fokussiert, wobei die Lichtquelle (10) winklig bezogen auf die Sichtlinie (12) zwischen dem linearen Detektorfeld (8) und der Seitenkante der Zeitungen (2) orientiert ist, wodurch Licht jenseits einer vorbestimmten Tiefenschärfe, di durch das Linsensyst m (6) definiert wird, ausr ichend unter dem instellbaren Schwellenwertpegel liegt und die Seitenkanten der Zeitungen, die auf das lin are Det ktorf ld (8) fokussiert werd n, beleuchtet werden.

3. System zum Erhalten ein s Zählwertes von überlappten Z itungen (2), die Seitenkanten haben, wobei die Zeitungen (2) auf einem sich bewegenden Förderer transportiert werden, welches umfaßt:

ein lineares CCD-Feld (8), das quer zu den Seitenkanten der Zeitungen (2) und quer zur Förderer-Bewegungsachse orientiert ist;

ein Mittel (6) für das optische Fokussieren des Seitenbildes der Zeitungen auf dem linearen CCD-Feld (8);

ein Mittel (32) für das kontinuierliche serielle Verschieben von Ausgabesignalen (30) von dem linearen CCD-Feld (8) mit einer durch einen Taktgeber definierten Rate, **gekennzeichnet durch:**

ein Signalverarbeitungsmittel (44) für das Empfangen der seriell verschobenen Ausgangssignale (30) von dem linearen CCD-Feld (8), nachdem alle Ausgangssignale von diesem linearen CCD-Feld (8) verschoben worden sind,

wobei dieses Signalverarbeitungsmittel (44) ein Mittel (254) für das Entwickeln von durch einen Taktgeber definierten sich wiederholenden sequentiellen digitalen Werten umfaßt, die, wenn die Zeitungen (2) vorbei an dem lineare CCD-Feld (8) gefördert werden, für das Oberseitenprofil der Zeitungen maßgeblich sind;

ein Mittel (300) für das Vergleichen jedes der digitalen Werte mit dem nächstvorangehenden dieser digitalen Werte, um Ableitungswerte des Oberseitenprofils der Zeitungen (2) zu erhalten;

ein Mittel (370) für das Auslösen eines Zeitungszählwert-Ausgabeinkrements, wenn sich dieser Ableitungswert vom Positiven zum Negativen ändert;

ein Mittel (382), um einen neuen definitiven Zeitungs-Dickenwert aus einem Vergleich zwischen dem vorhergehenden Zeitungs-Oberseitenprofil- und dem gegenwärtigen Zeitungs-Oberseitenprofilwert und einen Differenzwert zu entwickeln, der aus Änderungen von Stichprobe zu Stichprobe vom Positiven zum Negativen der gegenwärtigen Zeitung berechnet wird, wobei dieses Zeitungs-Zählwertausgangssignal ein einzelnes Zählwertinkrement umfaßt, wenn der definitive Zeitungs-Dikkenwert einen geeichten Dickenwert überschreitet, und wobei dieses Zeitungs-Zählwertausgangssignal ein doppeltes Zählwertinkrement umfaßt, w nn der Z itungsdickenw rt ein n zweiten geeicht n Dickenwert üb rschreitet.

4. Syst m nach Anspruch 3, wobei das Mitt l (6) für

das optisch Fokussi r n d s Seit nbild s der Zeitungen (2) auf das linear CCD-Feld (8) ine Lichtquelle (10), ein Lichtabschirm lem nt (14), das einen darin ausgebildeten länglichen Durchgangsschlitz (4) umfaßt, w bei dies r Schlitz (4) quer zur Oberfläche des Zeitungsförderers orientiert ist, und ein Linsensystem (6) umfaßt, das entlang der Sichtlinie (12) zwischen dem Schlitz (4) und dem CCD-Feld (8) angeordnet ist, wobei dieses Linsensystem (6) das durch den Schlitz definierte Bild der Seitenkanten der Zeitungen (2) auf dem linearen CCD-Feld (8) fokussiert, wobei die Lichtquelle (10) winklig bezogen auf die Sichtlinie (12) zwischen dem linearen CCD-Feld (8) und der Seitenkante der Zeitungen (2) orientiert ist, wodurch Licht jenseits einer vorbestimmten Tiefenschärfe, die durch das Linsensystem (6) definiert wird, um einen angemessenen Wert unterhalb des einstellbaren Schwellenwert-Feststellpegels liegt und die Seitenkanten der Zeitungen, die auf dem linearen CCD-Feld (8) fokussiert werden, beleuchtet werden.

5. Verfahren, um einen Zählwert für überlappte Zeitungen (2), die auf einem sich bewegenden Förderer transportiert werden, durch Bildanalyse des Bildes der Seitenkanten dieser Zeitungen (2) zu erhalten, wenn das fokussierte Bild auf ein lineares CCD-Feld (8) auftrifft, das quer zu den Zeitungs-Seitenkanten (2) und quer zur Förderer-Bewegungsachse orientiert ist, welches Verfahren die folgenden sich wiederholenden, sequentiellen Schritte umfaßt:

   serielles Verschieben analoger Ausgangssignale (16) aus dem linearen CCD-Feld (8) und eines Referenz-Lichtpegel-Ausgangssignals (20) zu einem Differentialverstärker (22), um den Gleichstrom-Offset daraus zu entfernen, es zu verstärken und Hochfrequenzrauschen daraus zu entfernen;

   Konvertieren (28) des analogen Ausgangssignals aus dem Differentialverstärker (22) in ein serielles digitales Ausgangssignal (30), wie es durch einen gewählten Lichtpegel definiert wird;

   Anlegen des seriellen digitalen Ausgangssignals (30) an ein Schieberegister (32) mit seriellem Eingang und parallelem Ausgang;

   Speichern des parallelen Ausgangs aus dem Schieberegister (32) in einem Speicher mit adressierbarem Zugriff (36), **gekennzeichnet durch:**

   Übertragen der Daten in dem Speicher mit adressierbarem Zugriff (36) in einen Mikroprozessor (44) für das Entwickeln (254) ines d finitiv n W rtes des Oberseitenprofils des Zeitungsbildes, wie s auf dem lin aren CCD-F ld (8) erscheint, nachdem all analogen Ausgangssignal aus d m linear n CCD-Feld (8) verschoben w rden sind;

   Erhalten der Differenz (300) zwischen aufeinanderfolgenden definitiven Zeitungsbild-Oberseitenwerten, um einen Wert zu erhalten, der definitiv für die Änderungsrate der definitiven Oberseitenwerte ist;

   Bestimmen (370) der Dicke der Zeitungen, wenn sich die Änderungsrate der definitiven Oberseitenwerte vom Positiven zum Negativen ändert;

   Auslösen (382) eines einzelnen Zählwertinkrements, wenn die Änderungsrate aufeinanderfolgender definitiver Oberseiten-Zählwerte vom Positiven zum Negativen übergeht und die gemessene Dicke der Zeitungen einen ersten geeichten Dickenwert überschreitet; und

   Auslösen (382) eines doppelten Zählwertinkrements, wenn sich die Änderungsrate aufeinanderfolgender definitiver Oberseitenwerte vom Positiven zum Negativen ändert und die gemessene Dicke der Zeitungen einen zweiten geeichten Dikkenwert überschreitet.

Revendications

1. Système pour obtenir un compte de journaux qui se chevauchent (2) ayant des bords latéraux, les journaux (2) étant portés sur un moyen d'acheminement mobile, comprenant :
   des premiers moyens (16) pour focaliser optiquement l'image de côté des journaux (2) sur une barrette de détecteur linéaire (8), ladite barrette de détecteur linéaire (8) étant disposée transversalement par rapport aux bords latéraux des journaux (2) et transversalement par rapport à l'axe de déplacement du moyen d'acheminement ;
   des seconds moyens (16) pour décaler en série des sorties analogiques à une cadence définie par une horloge de la barrette de détecteur linéaire (8) vers un amplificateur différentiel (22), ledit amplificateur différentiel recevant de plus une sortie de niveau de noir de référence (20) de la barrette de détecteur linéaire (8) pour en enlever le décalage de courant continu ;
   des troisièmes moyens (28) qui reçoivent la sortie (24) de l'amplificateur différentiel mentionné (22) et qui convertissent ladite sortie (24) de l'amplificateur différentiel en un signal de sortie numérique série (30) tel qu'il est défini par un niveau de lumière sélectionné,
   un registre à décalage entrée série/sortie paral-l`le (32) qui reçoit le signal d sorti (30) d s troisièmes moyens (28), système caractérisé par :
   un microprocesseur (44) pour dév l pper un valeur de profil supérieur d'image de l'image de déroulement des journaux telle qu'ell apparaît

dans ladite barrette d détecteur linéaire (8) basée sur la sortie du registre à décalage mentionné (32) après qu toutes les sorties analogiques aient été décalé s de ladite barrette de détecteur linéaire (8) ;
des moyens (300) pour comparer la différence entre des valeurs de profil supérieur successives d'image de journaux pour obtenir une dérivée de valeurs successives de profil supérieur d'image ;
des moyens (370) pour lancer une sortie de compte de journaux lorsque le taux de changement de valeurs de profil supérieur d'image successives change de positif à négatif et
des moyens (382) pour développer une valeur bien définie d'épaisseur de journaux, ladite sortie de compte de journaux comprenant une progression de compte simple lorsque ladite valeur bien définie d'épaisseur de journaux dépasse une valeur d'épaisseur étalonnée et ladite sortie de compte de journaux comprenant une progression de compte double lorsque ladite épaisseur de journaux mesurée dépasse une seconde valeur d'épaisseur étalonnée.

2. Système selon la revendication 1, dans lequel les moyens mentionnés (6) pour focaliser optiquement l'image de côté des journaux (2) sur ladite barrette de détecteur linéaire (8) comprennent une source de lumière (10), un organe de protection de la lumière (14) ayant une fente de passage allongée (4) qui y est formée, ladite fente (4) étant orientée en sens transersal de la surface du moyen d'acheminement des journaux, un système de lentilles (6) orienté le long de la ligne de vision (12) entre ladite fente (4) et ladite barrette de détecteur linéaire (8), ledit système de lentilles (6) focalisant l'image définie par la fente des bords latéraux des journaux (2) sur ladite barrette de détecteur linéaire (8), ladite source de lumière (10) étant orientée angulairement par rapport à la ligne de vision (12) entre ladite barrette de détecteur linéaire (8) et le bord latéral des journaux (2), la lumière au-delà d'une profondeur de champ prédéterminée définie par le système de lentilles (6) mentionné étant bien au-dessous du niveau de détection à seuil ajustable et les bords latéraux des journaux qui sont focalisés sur ladite barrette de détecteur linéaire (8) étant illuminés.

3. Système pour obtenir un compte de journaux qui se chevauchent (2) ayant des bords latéraux, les journaux (2) étant portés sur un moyen d'acheminement mobile, comprenant :
une barrette d'éléments photosensibles linéaires à transf rt de charg (8) orientés transversalement par rapp rt aux bords latéraux des journaux mentionnés (2) et transversalement par rapport à l'axe de déplacement du moyen d'acheminem nt ;
des moyens (6) pour focalis r optiquement l'image de côté des journaux sur ladite barrett d'élém nts photosensibl s linéaires à transfert de charge (8) ;
des moyens (32) pour décaler en série continuellement des sorties (30) de ladite barrette photosensibles linéaires à transfert de charge (8) à une cadence définie par une horloge, <u>système caractérisé par :</u>
des moyens de traitement de signal (44) pour recevoir les sorties décalées en série mentionnées (30) de ladite barrette d'éléments photosensibles linéaires à transfert de charge (8) après que toutes les sorties aient été décalées de ladite barrette d'éléments photosensibles linéaires à transfert de charge (8),
des moyens de traitement de signal (44) comprenant des moyens (254) pour développer des valeurs numériques séquentielles répétitives définies par horloge définitives du profil supérieur des journaux mentionnés lorsque les journaux mentionnés (2) sont acheminés le long de ladite barrette d'éléments photosensibles linéaires à transfert de charge (8),
des moyens (300) pour comparer chacune des valeurs numériques mentionnées à la prochaine valeur précédente des valeurs numériques mentionnées pour obtenir une valeur dérivée du profil des journaux mentionnés (2),
des moyens (370) pour initier une progression de sortie de compte de journaux lorsque ladite valeur dérivée change de positive à négative,
des moyens (382) pour développer une valeur définie d'épaisseur de journaux à partir d'une comparaison entre le profil supérieur de journaux antérieur et la valeur de profil supérieur de journaux existant et une valeur de différence calculée d'échantillon à échantillon qui change de positif à négatif du journal existant, ladite sortie de compte de journaux comprenant une progression de compte simple lorsque ladite valeur définitive de l'épaisseur de journaux dépasse une valeur d'épaisseur étalonnée et ladite sortie de compte de journaux comprenant une progression de double compte lorsque ladite valeur d'épaisseur de journaux dépasse une seconde valeur d'épaisseur étalonnée.

4. Système selon la revendication 3, dans lequel les moyens mentionnés (6) pour focaliser optiquement l'image de côté des journaux mentionnés (2) sur ladite barrette d'éléments photosensibles linéaires à transf rt de charge (8) comprend une source de lumière (10), un organe de protection d la lumière (14) ayant une fente de passage allongée (4) qui y est formée, ladite f nte (4) étant ori ntée en s ns transversal de la surface du

m yen d'acheminem nt des journaux mentionné, un système de lentilles (6) orienté le long de la ligne d vision (12) entre ladit fente (4) et ladit barr tte d'éléments photosensibles linéaires à transfert de charg (8), ledit système de lentilles (6) focalisant l'image définie par la fente des bords latéraux des journaux mentionnés (2) sur ladite barrette d'éléments photosensibles linéaires à transfert de charge (8), ladite source de lumière (10) étant orientée angulairement par rapport à la ligne de vision (12) entre ladite barrette d'éléments photosensibles linéaires à transfert de charge (8) et le bord latéral des journaux mentionnés (2), la lumière au-delà d'une profondeur de champ prédéterminée définie par le système de lentilles (6) mentionné étant bien au-dessous du niveau de détection à seuil ajustable et les bords latéraux des journaux qui sont focalisés sur ladite barrette d'éléments photosensibles linéaires à transfert de charge (8) étant illuminés.

5. Procédé d'obtention d'un compte de journaux qui se chevauchent (2) portés sur un moyen d'acheminement mobile par analyse de l'image des bords latéraux des journaux mentionnés (2) lorsque l'image focalisée est incidente sur une barrette d'éléments photosensibles linéaires à transfert de charge (8) orientée dans le sens transversal par rapport aux bords latéraux mentionnés des journaux (2) et dans le sens transversal de l'axe de déplacement du moyen d'acheminement, comprenant les étapes séquentielles répétitives :
de décaler sériellement les sorties analogiques (16) de la barrette d'éléments photosensibles linéaires à transfert de charge (8) et une sortie de niveau de luminère de référence (20) vers un amplificateur différentiel (22) pour en enlever le décalage de courant continu, amplifier et filtrer le bruit haute fréquence qui en vient ;
de convertir (28) le signal de sortie analogique de l'amplificateur différentiel mentionné (22) en un signal de sortie numérique série (30) tel qu'il est défini par un niveau de lumière sélectionné ;
d'appliquer ladite sortie numérique série (30) à un registre à décalage entrée série/sortie parallèle (32) ;
de mettre en mémoire la sortie parallèle du registre à décalage mentionné (32) dans une mémoire vive (36), procédé caractérisé par :
le transfert de données dans ladite mémoire vive (36) à un microprocesseur (44) pour développer (254) une valeur définitive du profil supérieur de l'image de journal tel qu'elle apparaît sur la barrette d'éléments photos nsibles linéaires à transfert de charge (8) après qu toutes l s sorti s analogiques aient été décalées d ladite barrette d'élém nts photosensibles linéaires à transfert d charge (8) ;
l'obtention de la différence (300) entr des valeurs définitives de profil supérieur d'image de journal successives pour obt nir une val ur définitive du taux de changem nt des valeurs définitives de profil supérieur mentionnées ;
la détermination (370) de l'épaisseur des journaux lorsque le taux de changement de la valeur définitive de profil supérieur change de positif à négatif ;
le lancement (382) d'une progression de compte simple lorsque le taux de changement de comptes successifs définitifs successifs de profil supérieur passe de positif à négatif et l'épaisseur mesurée des journaux dépasse une première valeur d'épaisseur étalonnée et
le lancement (382) d'une progression de compte double lorsque le taux de changement de valeurs définitives de profil supérieur successives change de positif à négatif et l'épaisseur mesurée des journaux dépasse une seconde valeur d'épaisseur étalonnée.

FIG. 1
(SIDE VIEW)

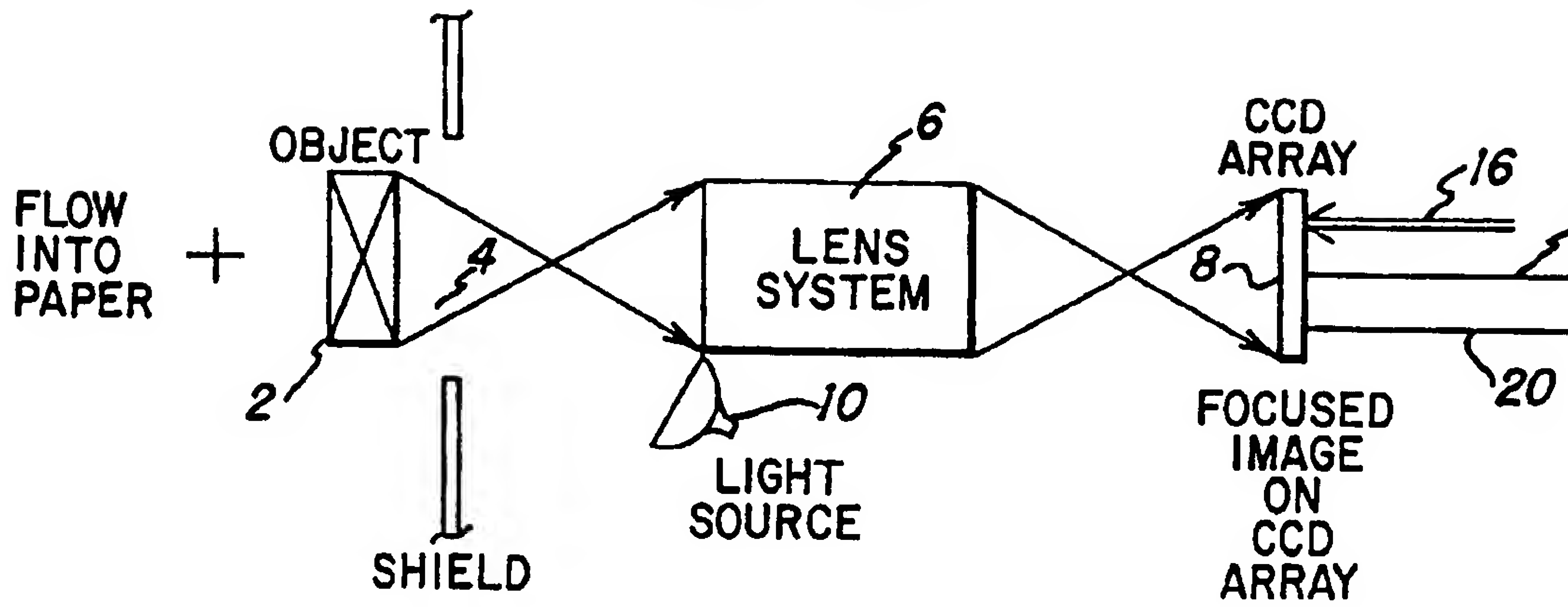
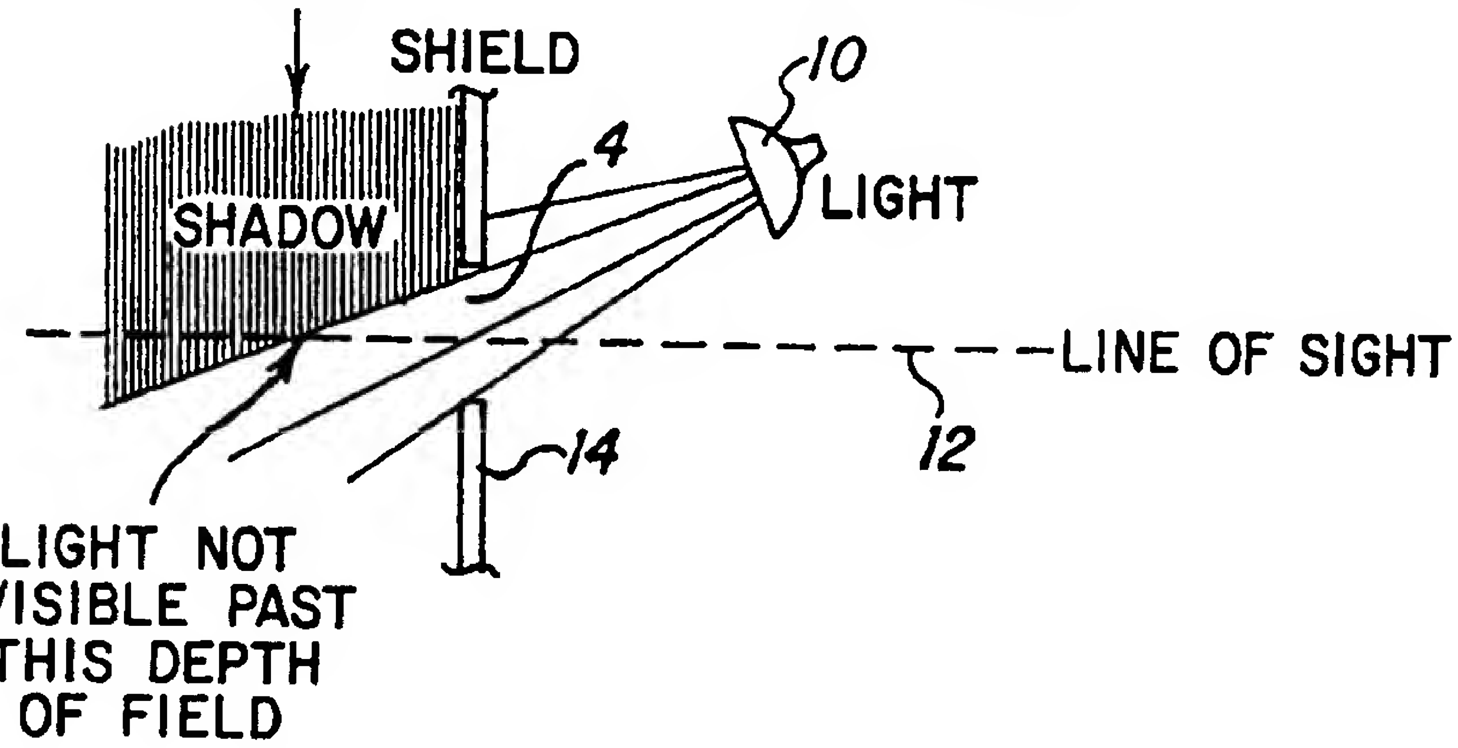


FIG. 2
(TOP VIEW)



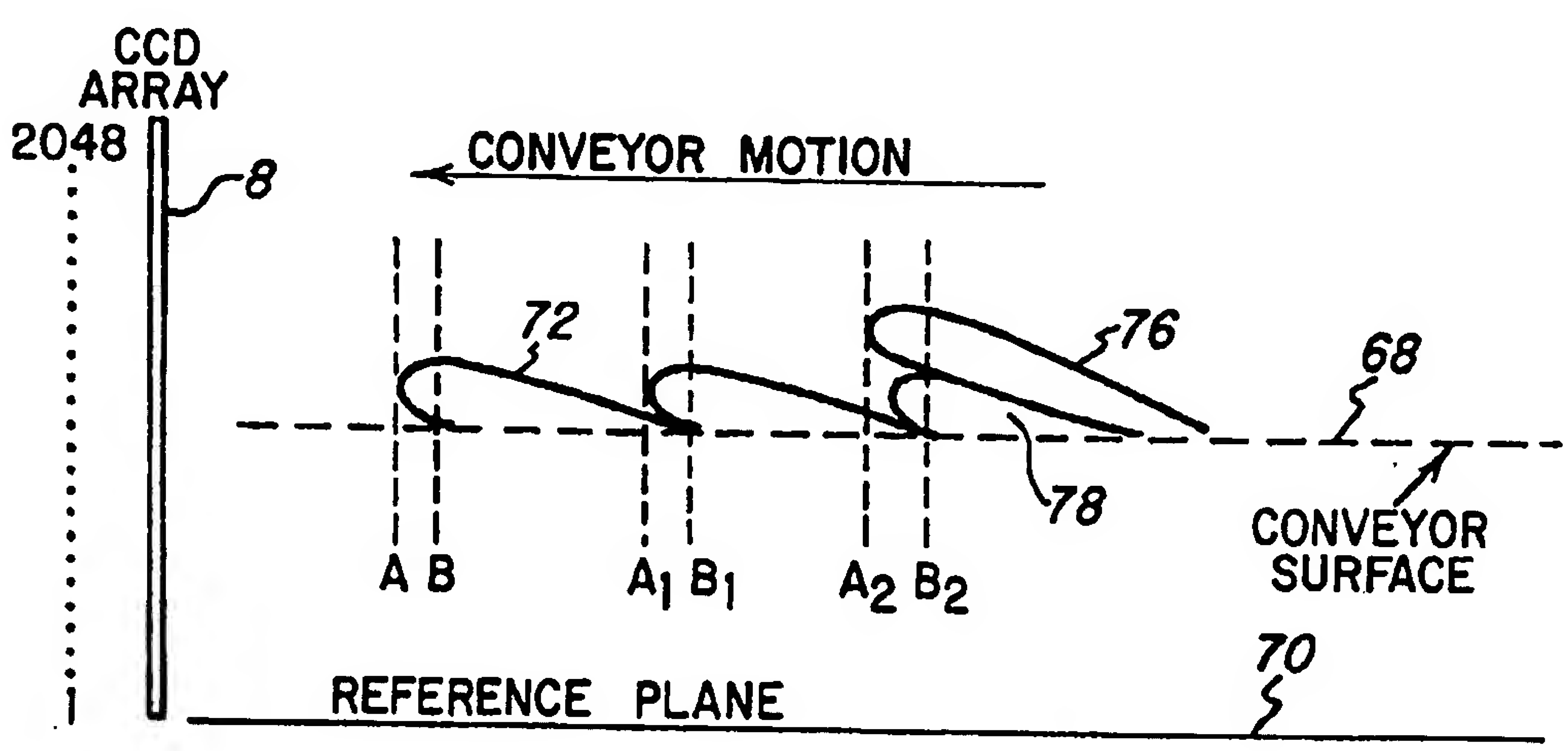


FIG. 5

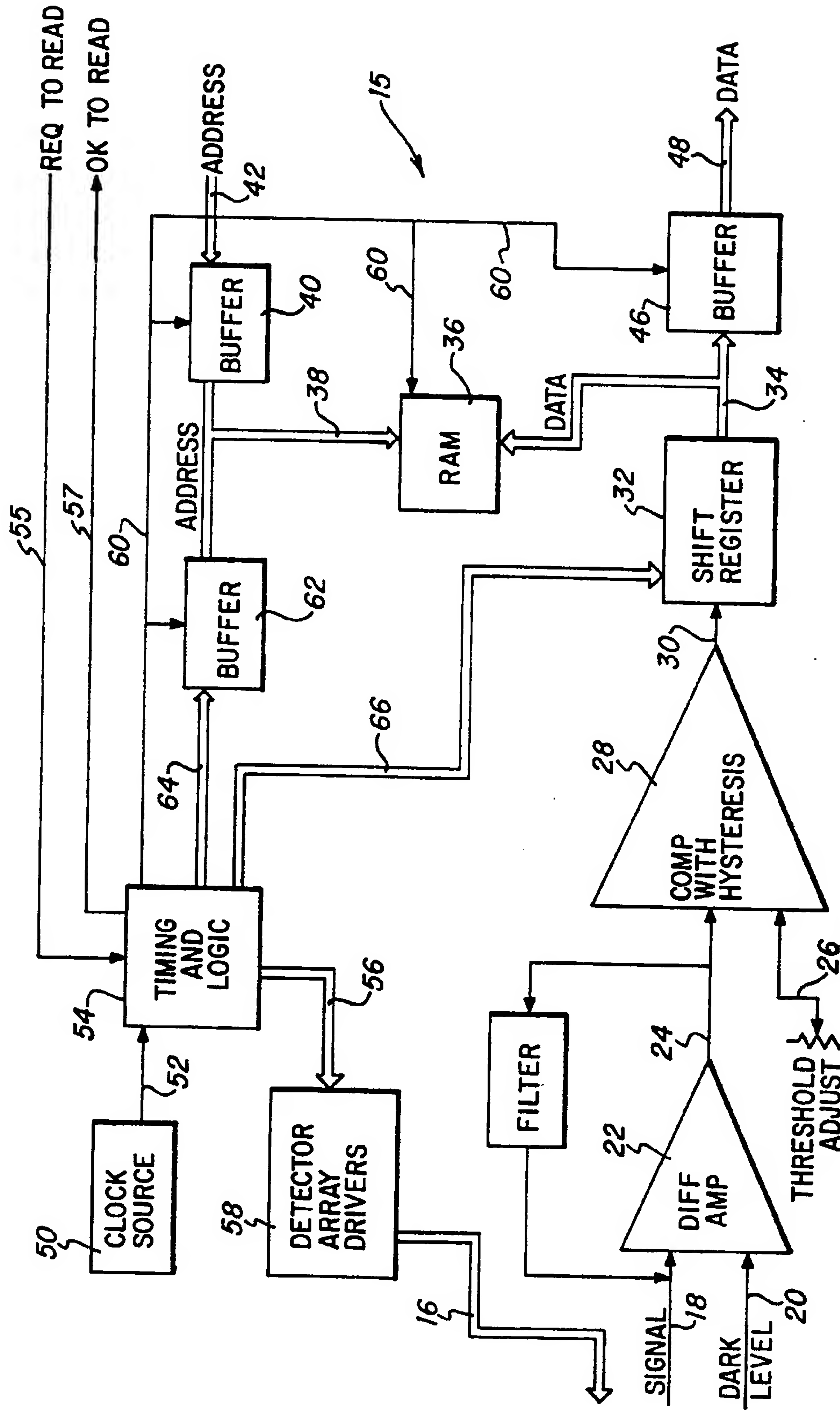
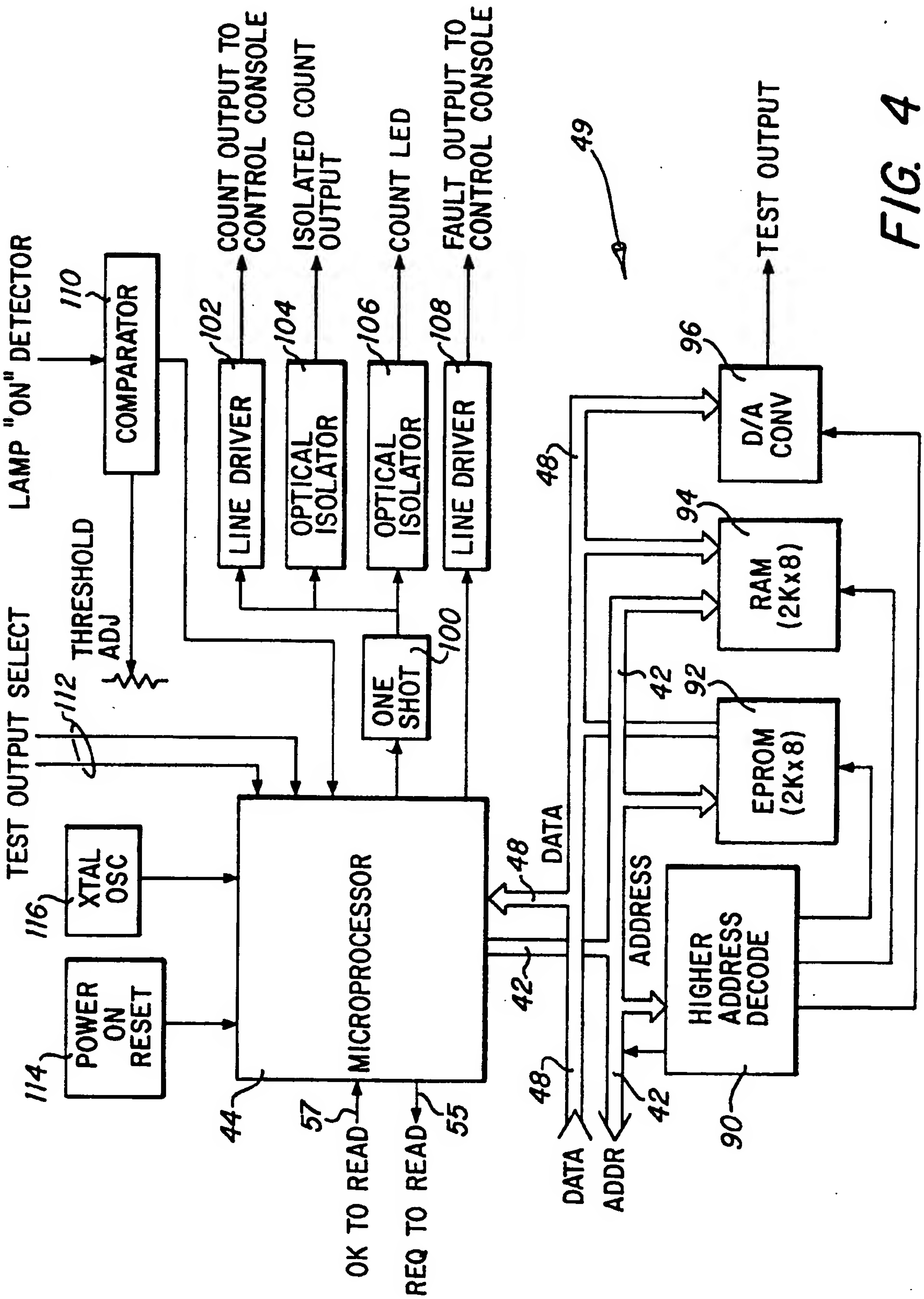

REQ TO READ
OK TO READ
ADDRESS
42
15
DATA
48
55
57
60
ADDRESS
BUFFER
40
60
60
RAM
36
38
DATA
46
BUFFER
34
32
SHIFT REGISTER
BUFFER
62
30
66
64
28
COMP WITH HYSTERESIS
TIMING AND LOGIC
54
56
52
CLOCK SOURCE
50
DETECTOR ARRAY DRIVERS
58
16
FILTER
24
26
THRESHOLD ADJUST
22
DIFF AMP
SIGNAL
18
DARK LEVEL
20

FIG. 3



LAMP "ON" DETECTOR
COMPARATOR
110
THRESHOLD ADJ
TEST OUTPUT SELECT
112
XTAL OSC
116
POWER ON RESET
114
MICROPROCESSOR
44
OK TO READ
57
REQ TO READ
55
ONE SHOT
100
LINE DRIVER
102
COUNT OUTPUT TO CONTROL CONSOLE
OPTICAL ISOLATOR
104
ISOLATED COUNT OUTPUT
OPTICAL ISOLATOR
106
COUNT LED
LINE DRIVER
108
FAULT OUTPUT TO CONTROL CONSOLE
49
DATA
48
42
ADDRESS
ADDR
HIGHER ADDRESS DECODE
90
EPROM (2Kx8)
92
RAM (2Kx8)
94
D/A CONV
96
TEST OUTPUT

FIG. 4

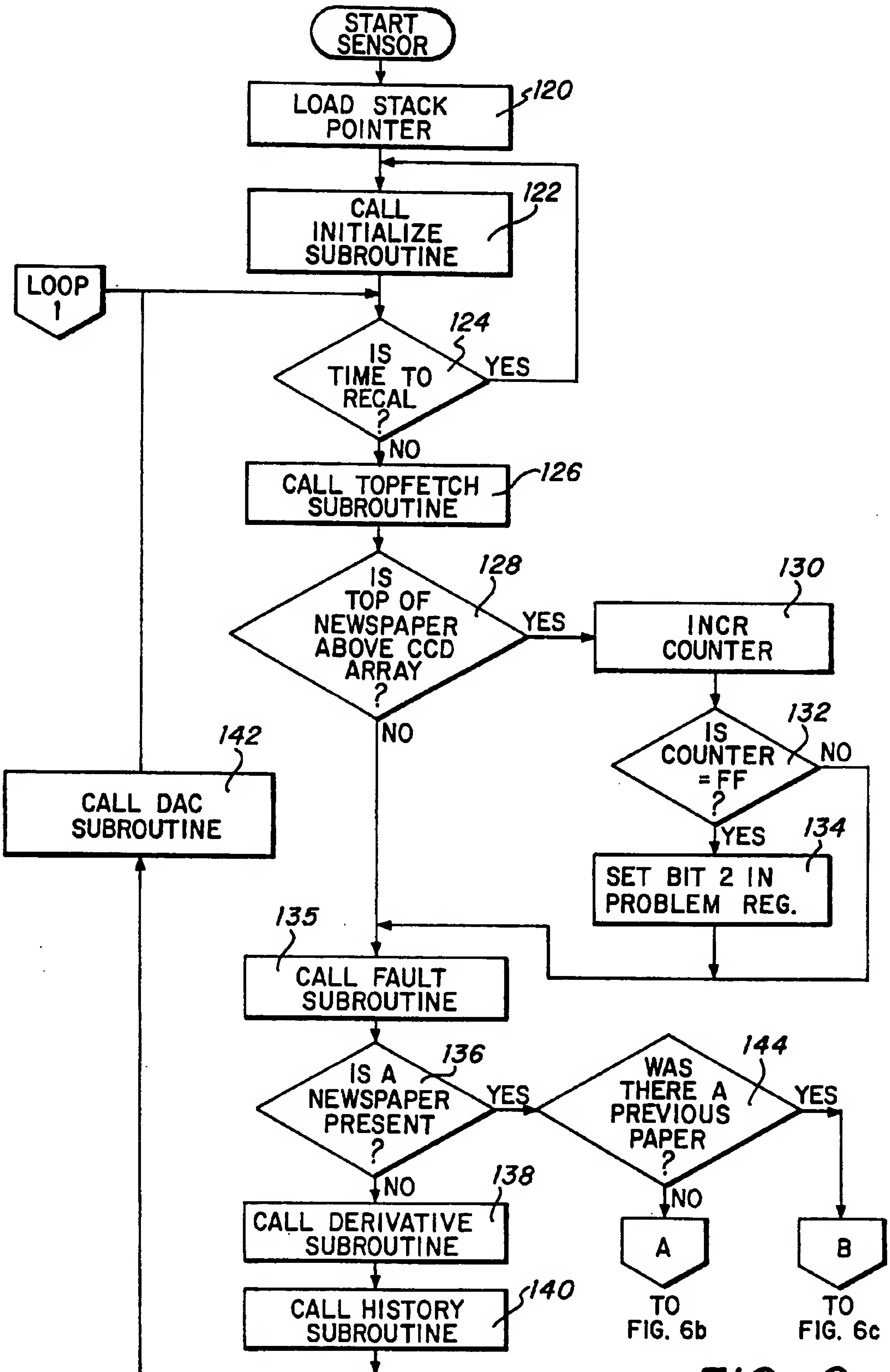

START SENSOR
LOAD STACK POINTER
120
CALL INITIALIZE SUBROUTINE
122
LOOP 1
IS TIME TO RECAL ?
124
YES
NO
CALL TOPFETCH SUBROUTINE
126
IS TOP OF NEWSPAPER ABOVE CCD ARRAY ?
128
YES
NO
INCR COUNTER
130
IS COUNTER = FF ?
132
NO
YES
SET BIT 2 IN PROBLEM REG.
134
CALL DAC SUBROUTINE
142
CALL FAULT SUBROUTINE
135
IS A NEWSPAPER PRESENT ?
136
YES
NO
WAS THERE A PREVIOUS PAPER ?
144
YES
NO
CALL DERIVATIVE SUBROUTINE
138
CALL HISTORY SUBROUTINE
140
A
TO FIG. 6b
B
TO FIG. 6c

FIG. 6a

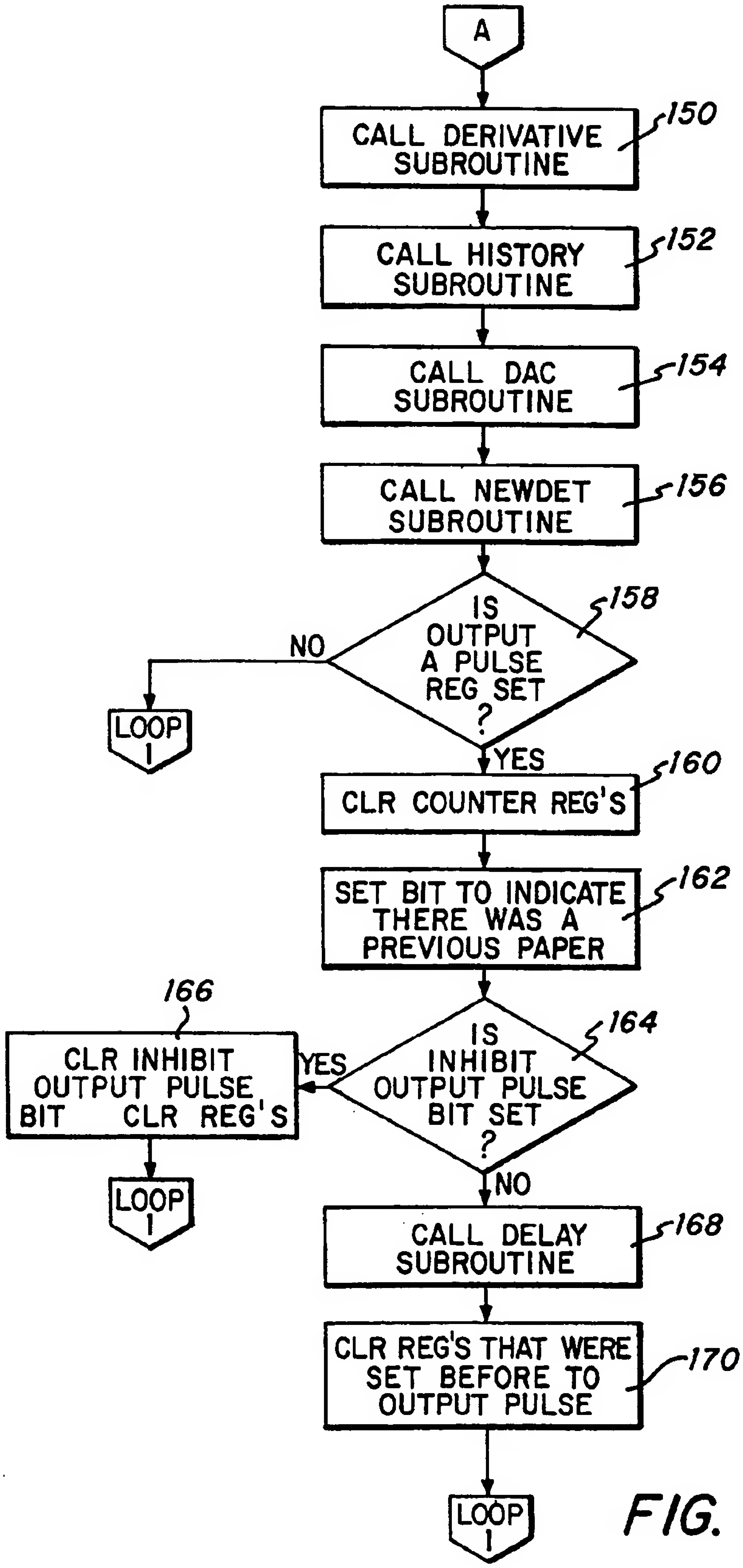

A
CALL DERIVATIVE SUBROUTINE
150
CALL HISTORY SUBROUTINE
152
CALL DAC SUBROUTINE
154
CALL NEWDET SUBROUTINE
156
IS OUTPUT A PULSE REG SET ?
158
NO
LOOP 1
YES
CLR COUNTER REG'S
160
SET BIT TO INDICATE THERE WAS A PREVIOUS PAPER
162
IS INHIBIT OUTPUT PULSE BIT SET ?
164
YES
CLR INHIBIT OUTPUT PULSE BIT CLR REG'S
166
LOOP 1
NO
CALL DELAY SUBROUTINE
168
CLR REG'S THAT WERE SET BEFORE TO OUTPUT PULSE
170
LOOP 1

FIG. 6b

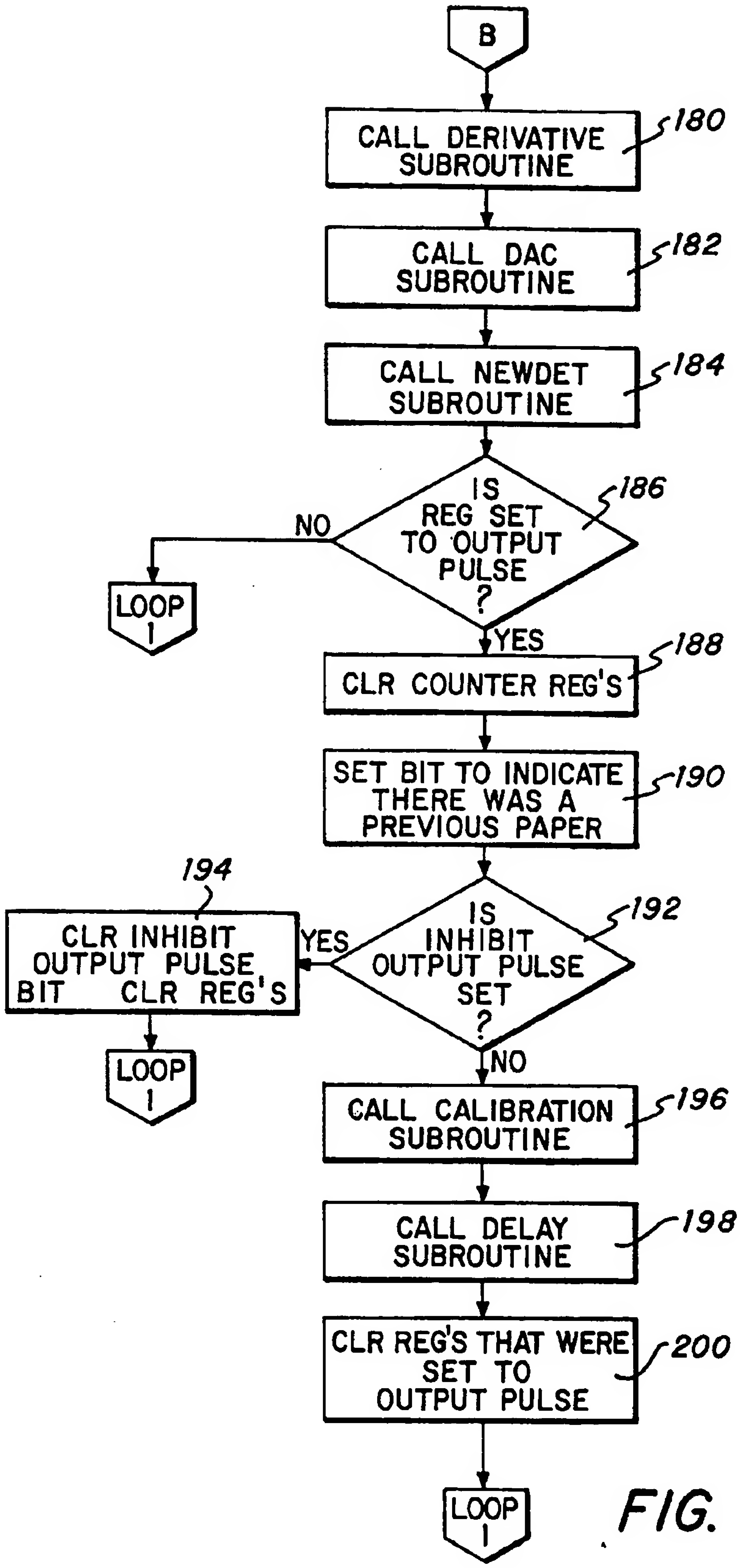

B
CALL DERIVATIVE SUBROUTINE
180
CALL DAC SUBROUTINE
182
CALL NEWDET SUBROUTINE
184
IS REG SET TO OUTPUT PULSE ?
186
NO
LOOP 1
YES
CLR COUNTER REG'S
188
SET BIT TO INDICATE THERE WAS A PREVIOUS PAPER
190
194
CLR INHIBIT OUTPUT PULSE BIT CLR REG'S
YES
IS INHIBIT OUTPUT PULSE SET ?
192
LOOP 1
NO
CALL CALIBRATION SUBROUTINE
196
CALL DELAY SUBROUTINE
198
CLR REG'S THAT WERE SET TO OUTPUT PULSE
200
LOOP 1

FIG. 6c

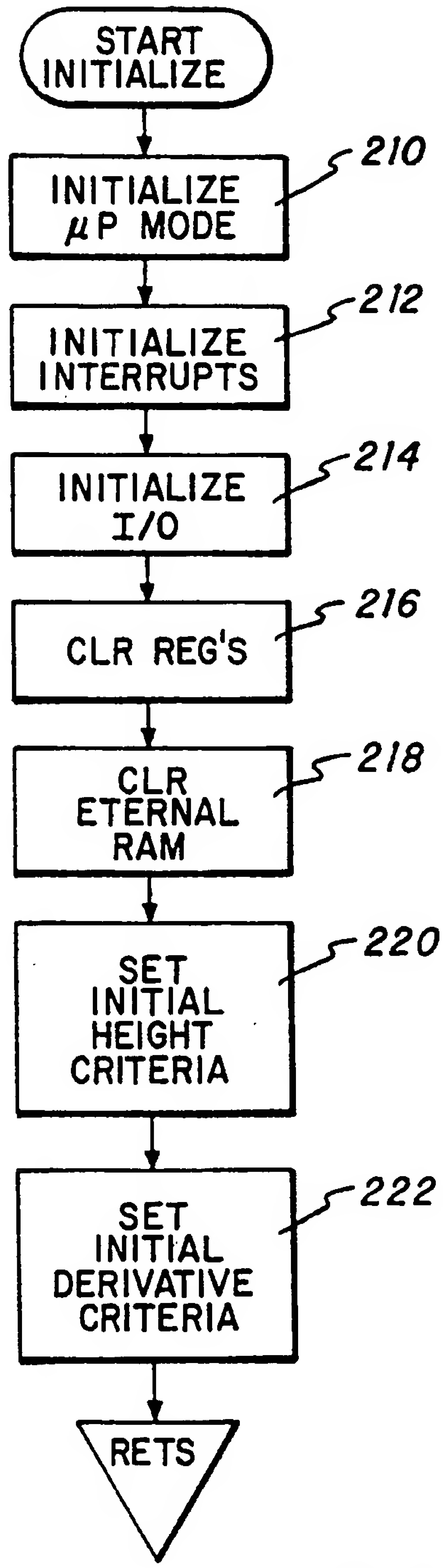

START INITIALIZE
INITIALIZE μP MODE
210
INITIALIZE INTERRUPTS
212
INITIALIZE I/O
214
CLR REG'S
216
CLR ETERNAL RAM
218
SET INITIAL HEIGHT CRITERIA
220
SET INITIAL DERIVATIVE CRITERIA
222
RETS

FIG. 6d

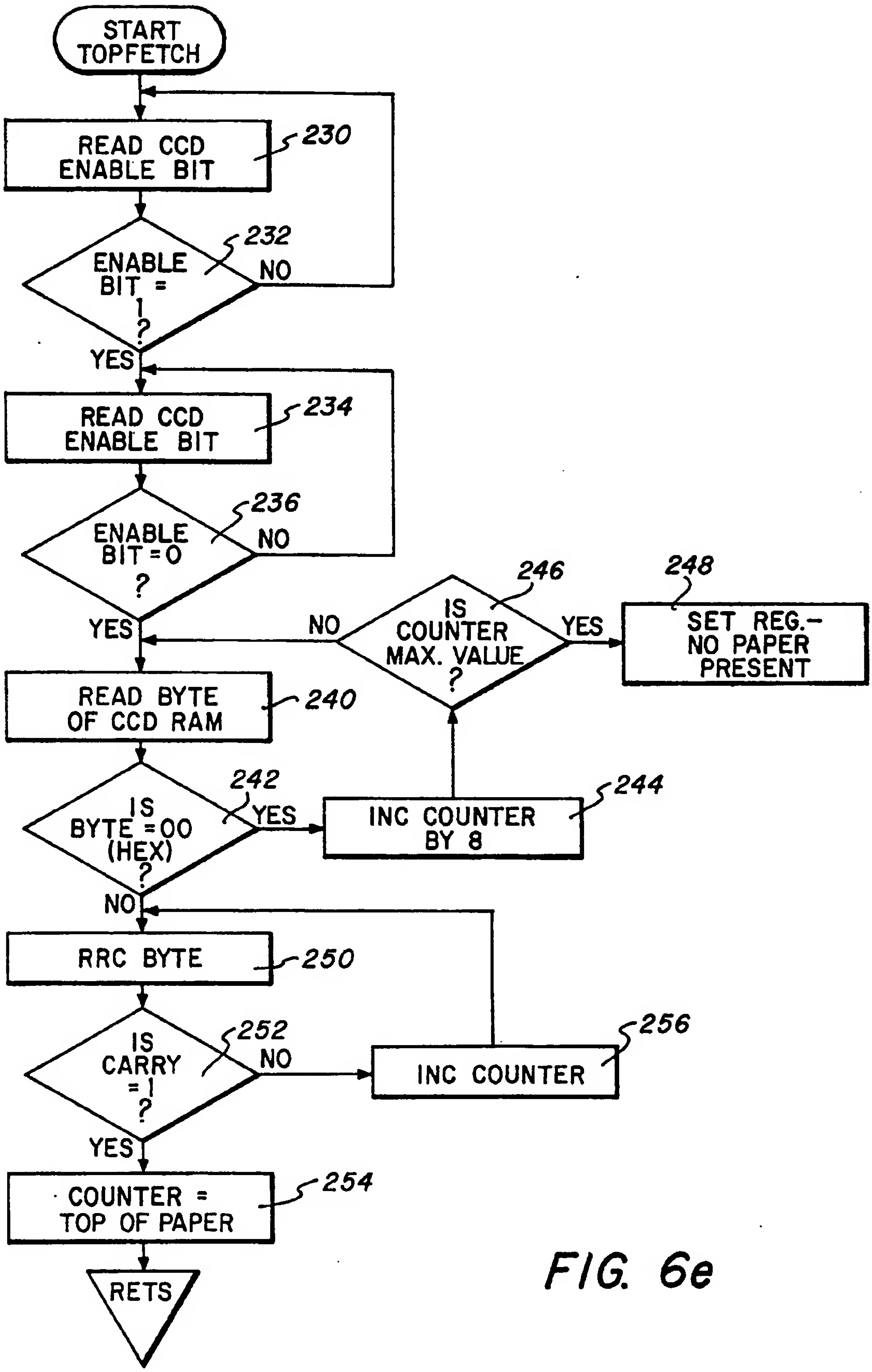

START TOPFETCH
READ CCD ENABLE BIT
230
ENABLE BIT = 1 ?
232
NO
YES
READ CCD ENABLE BIT
234
ENABLE BIT = 0 ?
236
NO
YES
IS COUNTER MAX. VALUE ?
246
NO
YES
SET REG.– NO PAPER PRESENT
248
READ BYTE OF CCD RAM
240
IS BYTE = 00 (HEX) ?
242
YES
INC COUNTER BY 8
244
NO
RRC BYTE
250
IS CARRY = 1 ?
252
NO
INC COUNTER
256
YES
COUNTER = TOP OF PAPER
254
RETS

FIG. 6e

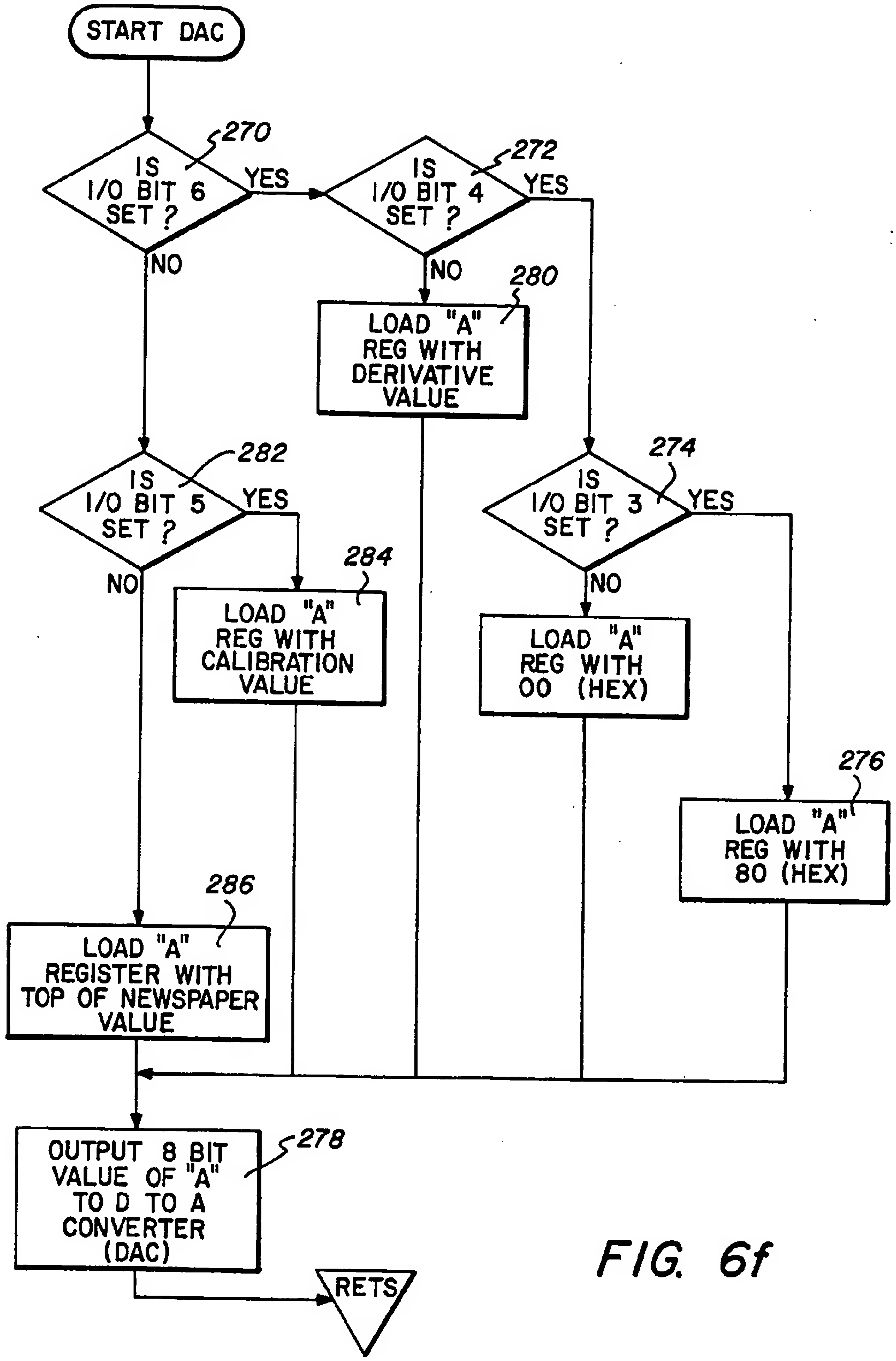

START DAC
IS I/O BIT 6 SET ?
270
YES
NO
IS I/O BIT 4 SET ?
272
YES
NO
280
LOAD "A" REG WITH DERIVATIVE VALUE
IS I/O BIT 5 SET ?
282
YES
NO
284
LOAD "A" REG WITH CALIBRATION VALUE
IS I/O BIT 3 SET ?
274
YES
NO
LOAD "A" REG WITH 00 (HEX)
276
LOAD "A" REG WITH 80 (HEX)
286
LOAD "A" REGISTER WITH TOP OF NEWSPAPER VALUE
OUTPUT 8 BIT VALUE OF "A" TO D TO A CONVERTER (DAC)
278
RETS

FIG. 6f

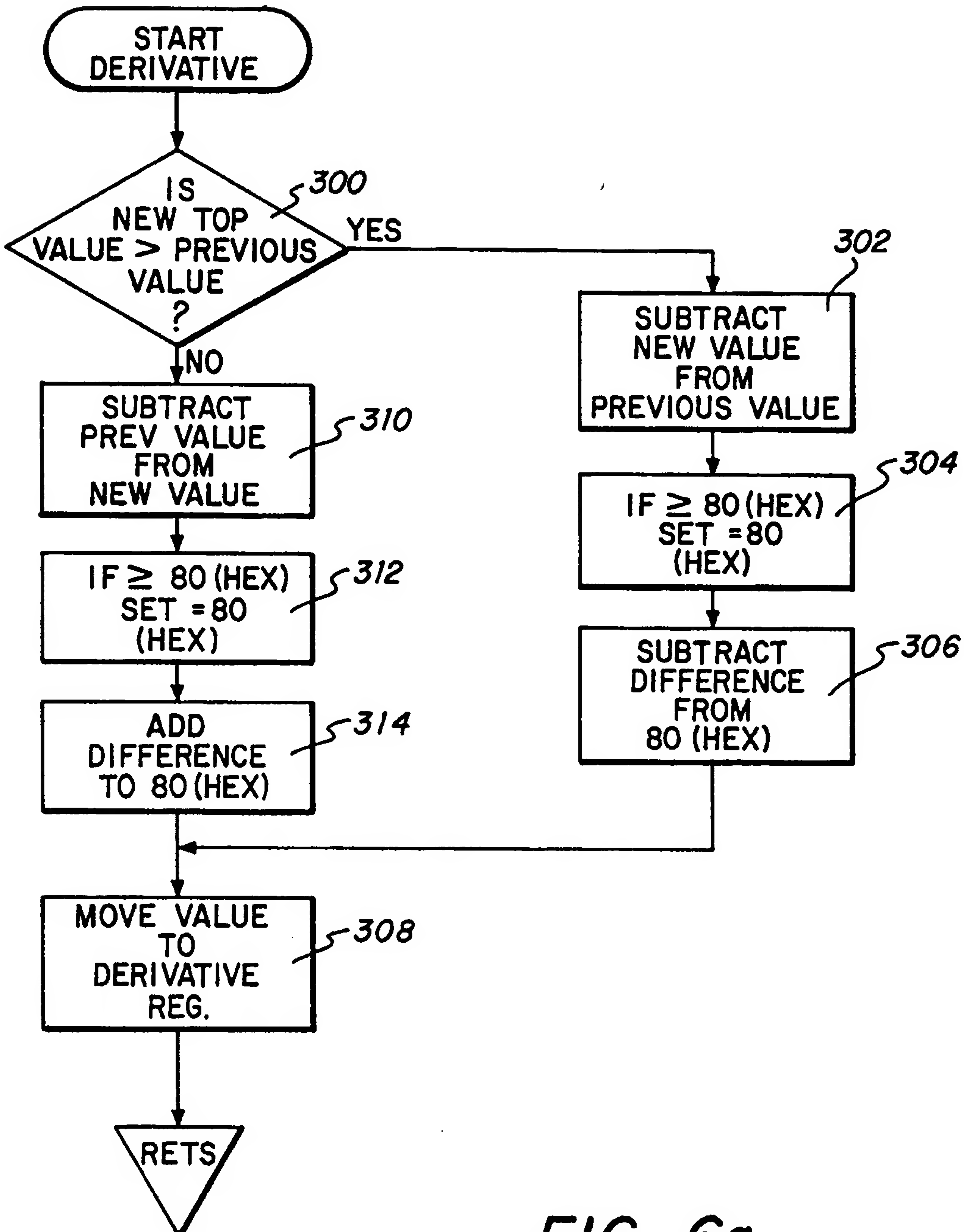

START
DERIVATIVE
IS
NEW TOP
VALUE > PREVIOUS
VALUE
?
300
YES
NO
302
SUBTRACT
NEW VALUE
FROM
PREVIOUS VALUE
SUBTRACT
PREV VALUE
FROM
NEW VALUE
310
304
IF ≥ 80 (HEX)
SET =80
(HEX)
IF ≥ 80 (HEX)
SET =80
(HEX)
312
306
SUBTRACT
DIFFERENCE
FROM
80 (HEX)
ADD
DIFFERENCE
TO 80 (HEX)
314
MOVE VALUE
TO
DERIVATIVE
REG.
308
RETS

FIG. 6g

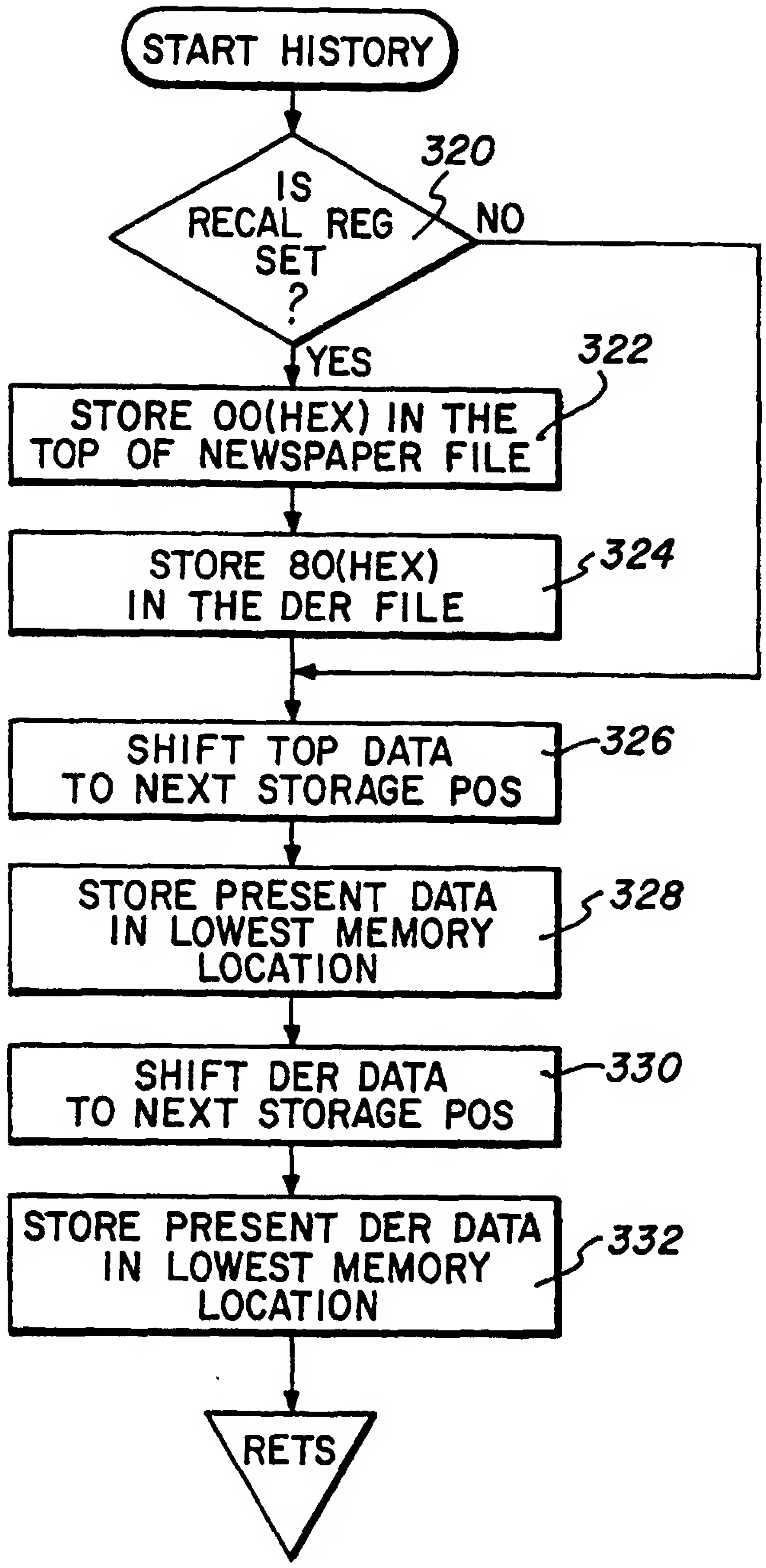

START HISTORY
IS RECAL REG SET ?
320
NO
YES
322
STORE 00(HEX) IN THE TOP OF NEWSPAPER FILE
324
STORE 80(HEX) IN THE DER FILE
326
SHIFT TOP DATA TO NEXT STORAGE POS
328
STORE PRESENT DATA IN LOWEST MEMORY LOCATION
330
SHIFT DER DATA TO NEXT STORAGE POS
332
STORE PRESENT DER DATA IN LOWEST MEMORY LOCATION
RETS

FIG. 6h

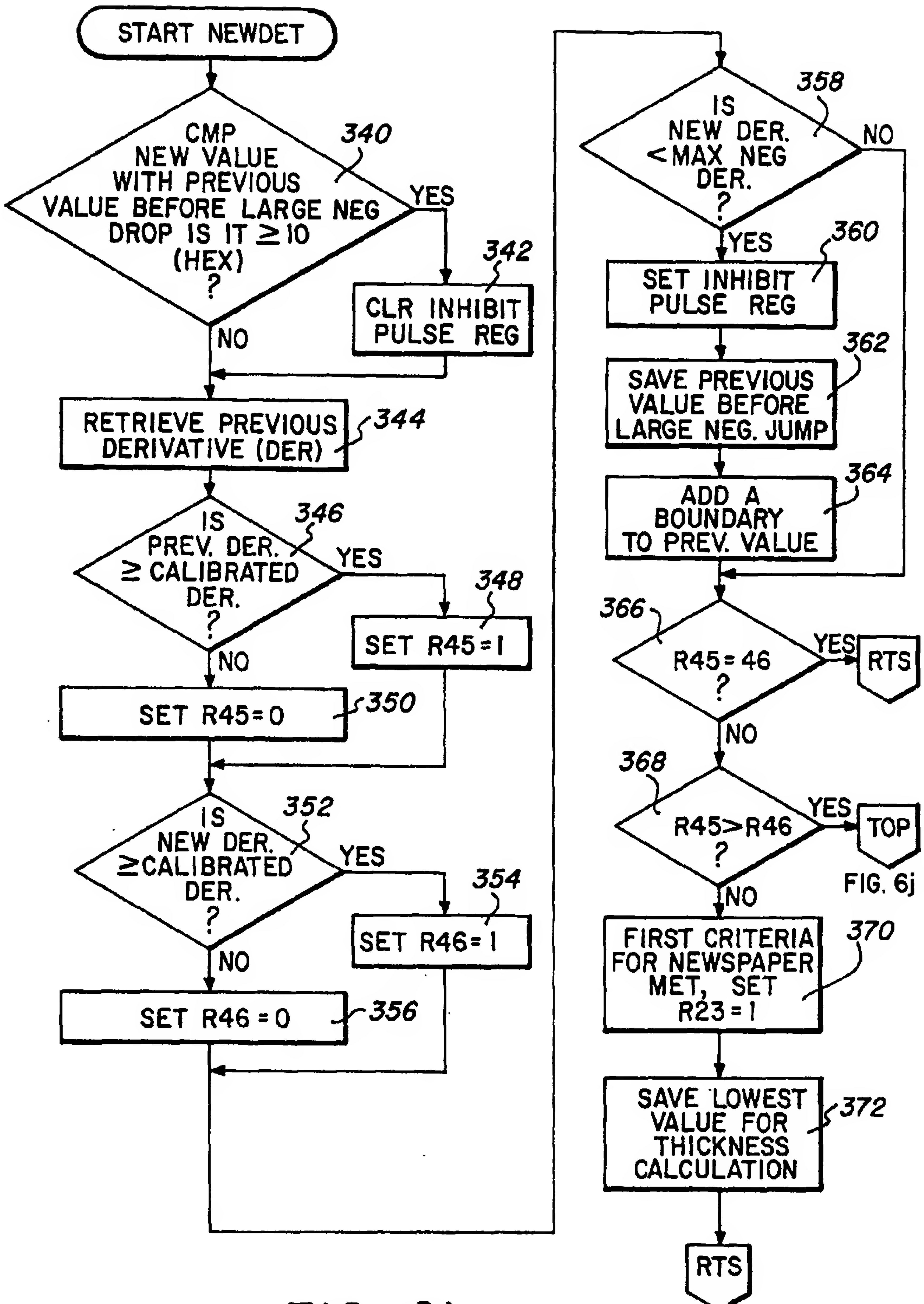

START NEWDET
CMP NEW VALUE WITH PREVIOUS VALUE BEFORE LARGE NEG DROP IS IT ≥10 (HEX) ?
340
YES
NO
342
CLR INHIBIT PULSE REG
RETRIEVE PREVIOUS DERIVATIVE (DER)
344
IS PREV. DER. ≥ CALIBRATED DER. ?
346
YES
NO
348
SET R45=1
SET R45=0
350
IS NEW DER. ≥CALIBRATED DER. ?
352
YES
NO
354
SET R46=1
SET R46=0
356
IS NEW DER. <MAX NEG DER. ?
358
NO
YES
360
SET INHIBIT PULSE REG
362
SAVE PREVIOUS VALUE BEFORE LARGE NEG. JUMP
364
ADD A BOUNDARY TO PREV. VALUE
366
R45=46 ?
YES
RTS
NO
368
R45>R46 ?
YES
TOP
FIG. 6j
NO
FIRST CRITERIA FOR NEWSPAPER MET, SET R23=1
370
SAVE LOWEST VALUE FOR THICKNESS CALCULATION
372
RTS

FIG. 6i

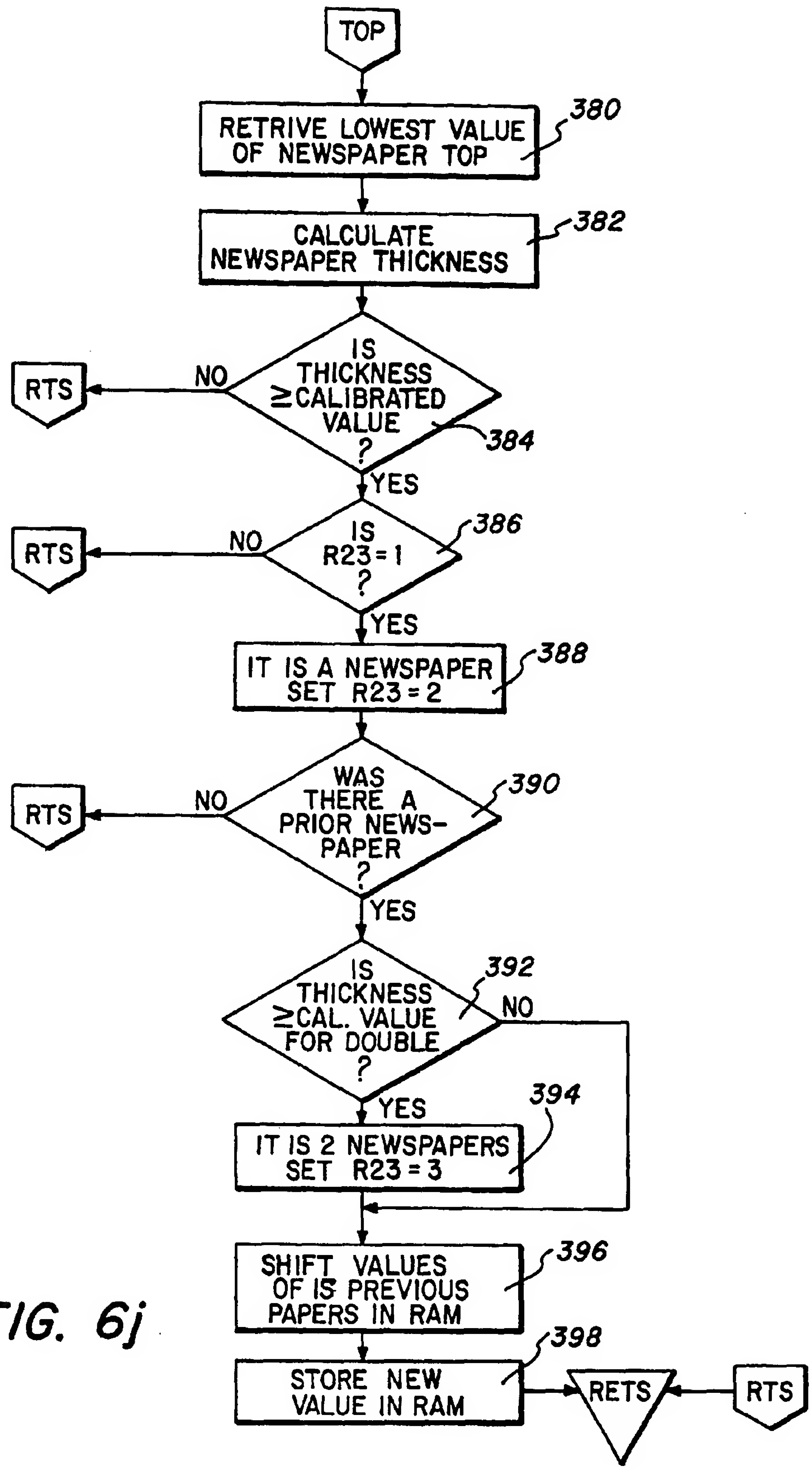

TOP
RETRIVE LOWEST VALUE OF NEWSPAPER TOP
380
CALCULATE NEWSPAPER THICKNESS
382
IS THICKNESS ≥CALIBRATED VALUE ?
384
NO
RTS
YES
IS R23=1 ?
386
NO
RTS
YES
IT IS A NEWSPAPER SET R23=2
388
WAS THERE A PRIOR NEWS-PAPER ?
390
NO
RTS
YES
IS THICKNESS ≥CAL. VALUE FOR DOUBLE ?
392
NO
YES
IT IS 2 NEWSPAPERS SET R23=3
394
SHIFT VALUES OF IS PREVIOUS PAPERS IN RAM
396
STORE NEW VALUE IN RAM
398
RETS
RTS

FIG. 6j

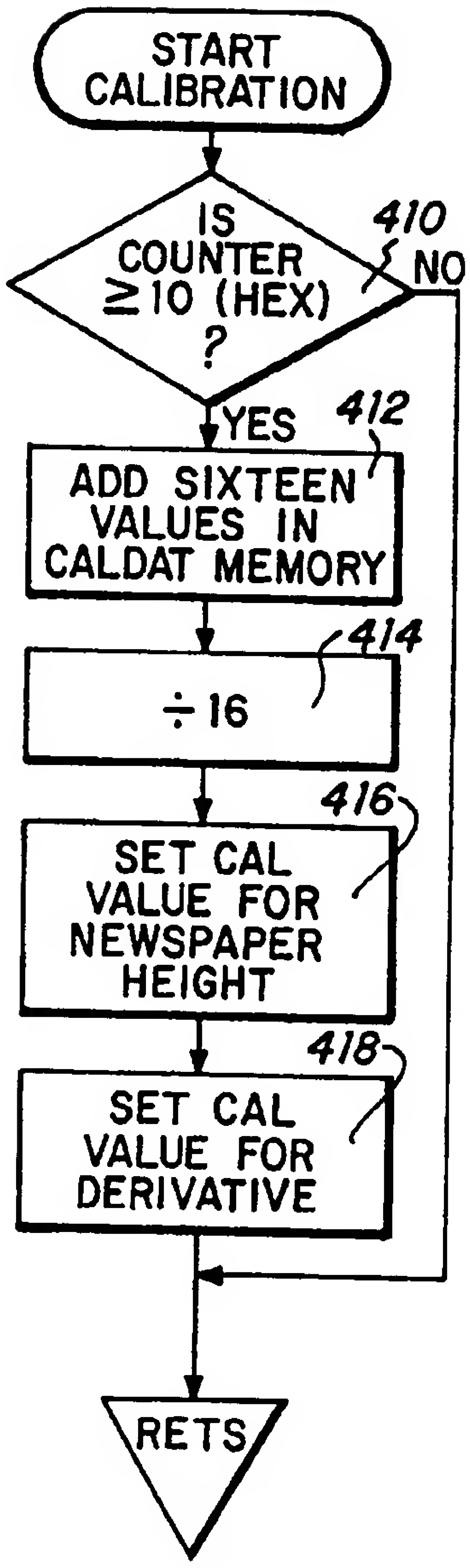

START CALIBRATION
IS COUNTER ≥10 (HEX) ?
410
NO
YES
412
ADD SIXTEEN VALUES IN CALDAT MEMORY
414
÷16
416
SET CAL VALUE FOR NEWSPAPER HEIGHT
418
SET CAL VALUE FOR DERIVATIVE
RETS

FIG. 6k

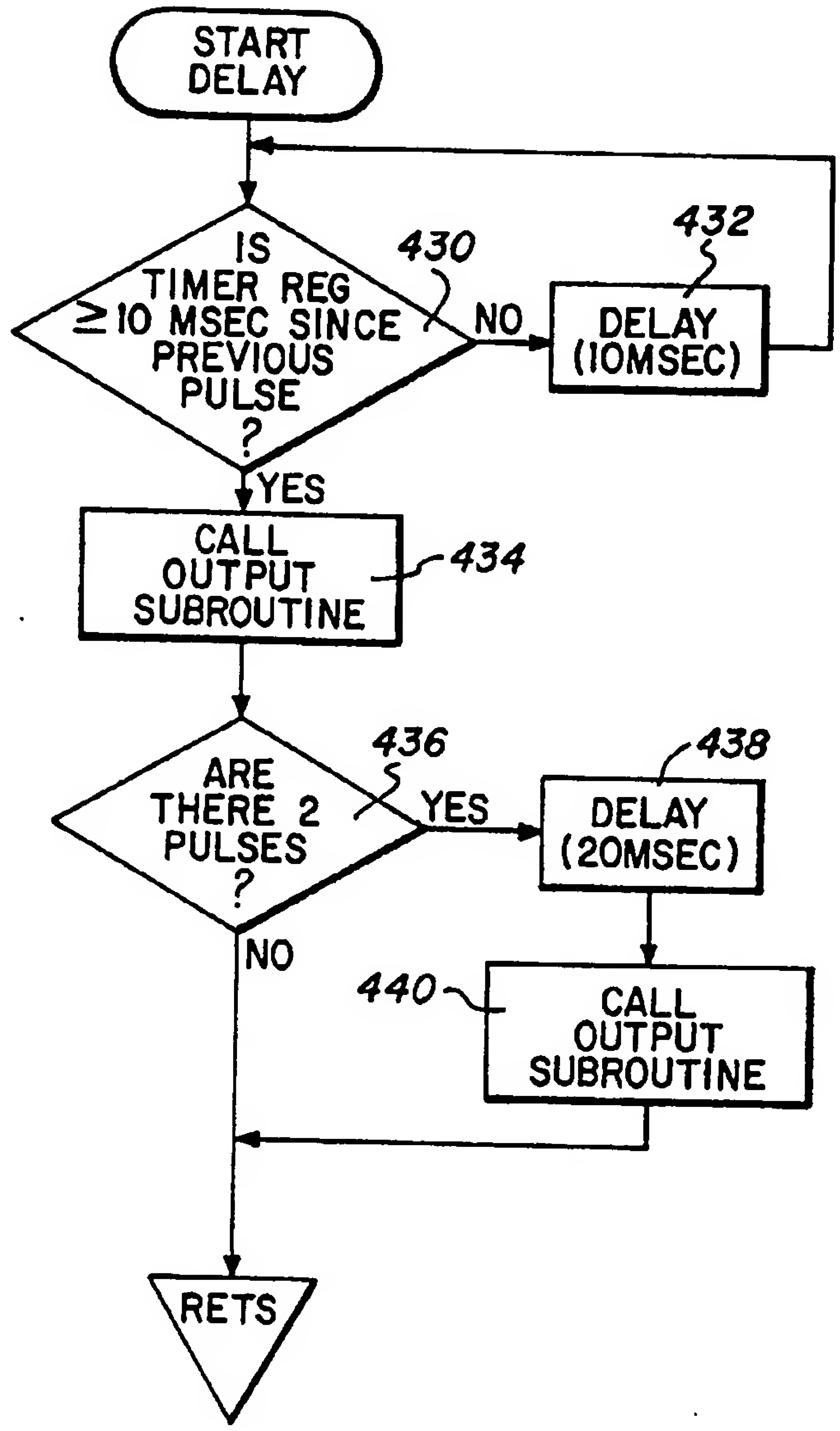

START DELAY
IS TIMER REG ≥10 MSEC SINCE PREVIOUS PULSE ?
430
NO
432
DELAY (10MSEC)
YES
CALL OUTPUT SUBROUTINE
434
ARE THERE 2 PULSES ?
436
YES
438
DELAY (20MSEC)
NO
440
CALL OUTPUT SUBROUTINE
RETS

FIG. 6L

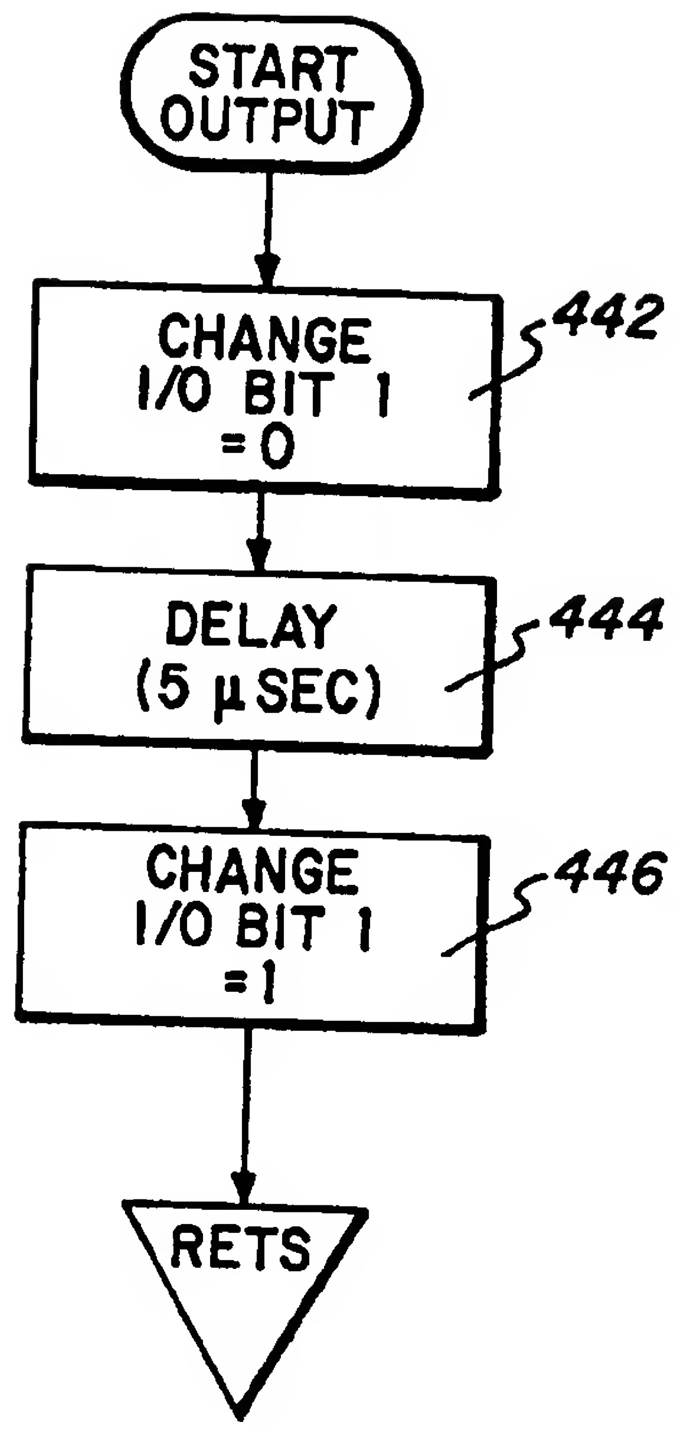

START OUTPUT
CHANGE I/O BIT 1 =0
442
DELAY (5 µSEC)
444
CHANGE I/O BIT 1 =1
446
RETS

FIG. 6m

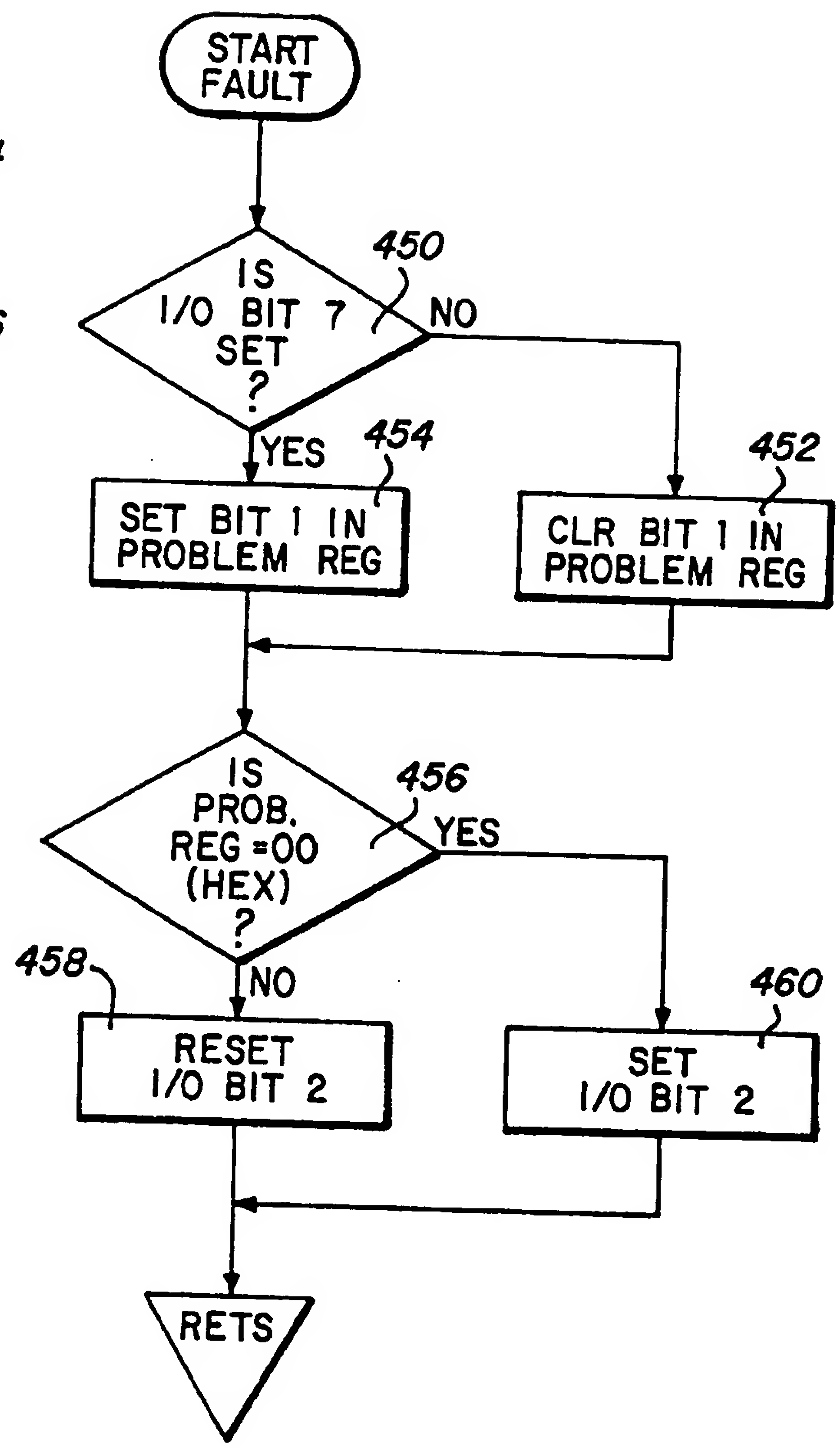

START FAULT
IS I/O BIT 7 SET ?
450
NO
YES
454
SET BIT 1 IN PROBLEM REG
452
CLR BIT 1 IN PROBLEM REG
IS PROB. REG =00 (HEX) ?
456
YES
NO
458
RESET I/O BIT 2
460
SET I/O BIT 2
RETS

FIG. 6n

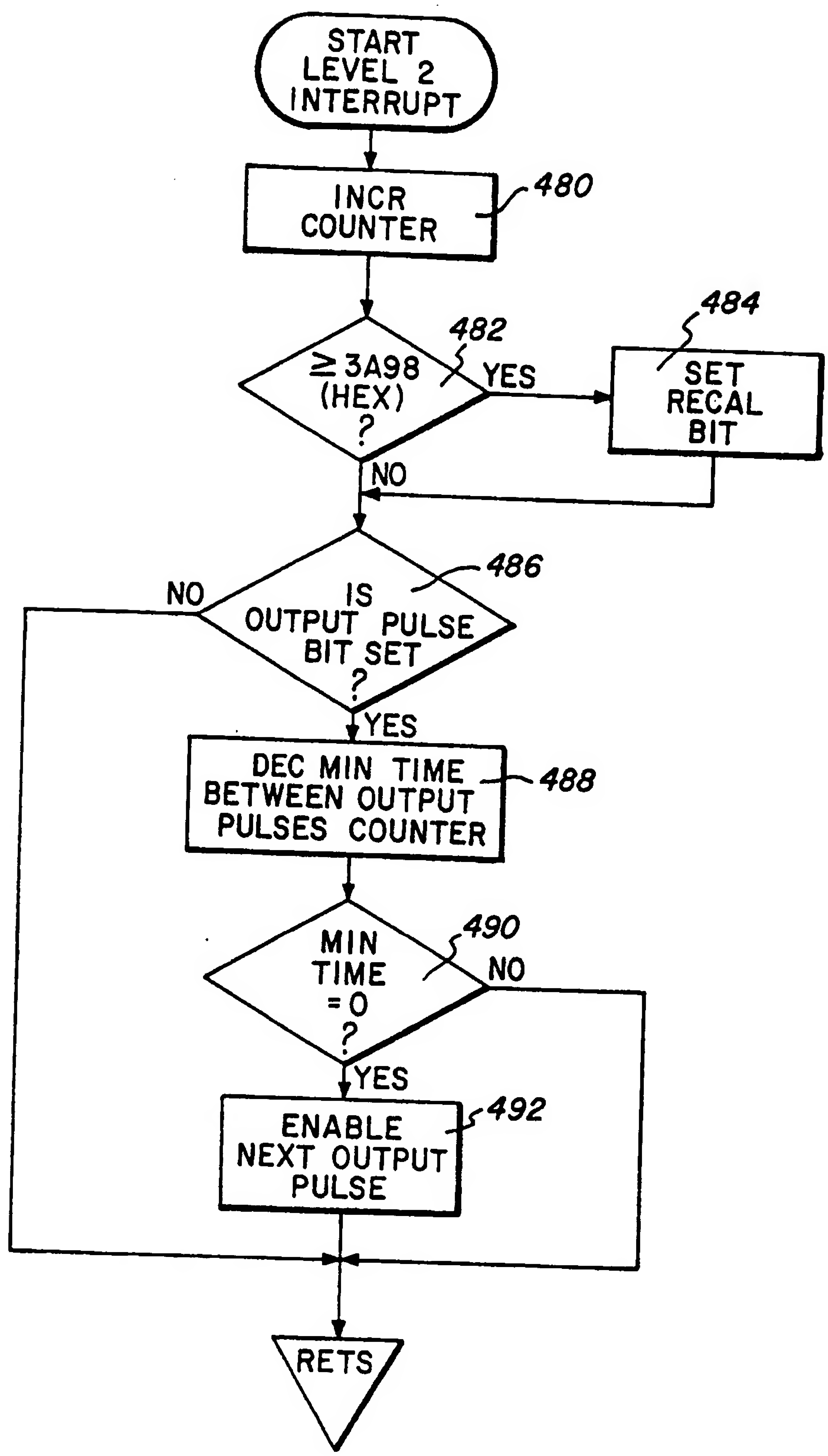

START
LEVEL 2
INTERRUPT
INCR
COUNTER
480
≥3A98
(HEX)
?
482
YES
484
SET
RECAL
BIT
NO
486
NO
IS
OUTPUT PULSE
BIT SET
?
YES
DEC MIN TIME
BETWEEN OUTPUT
PULSES COUNTER
488
MIN
TIME
=0
?
490
NO
YES
ENABLE
NEXT OUTPUT
PULSE
492
RETS

FIG. 6o